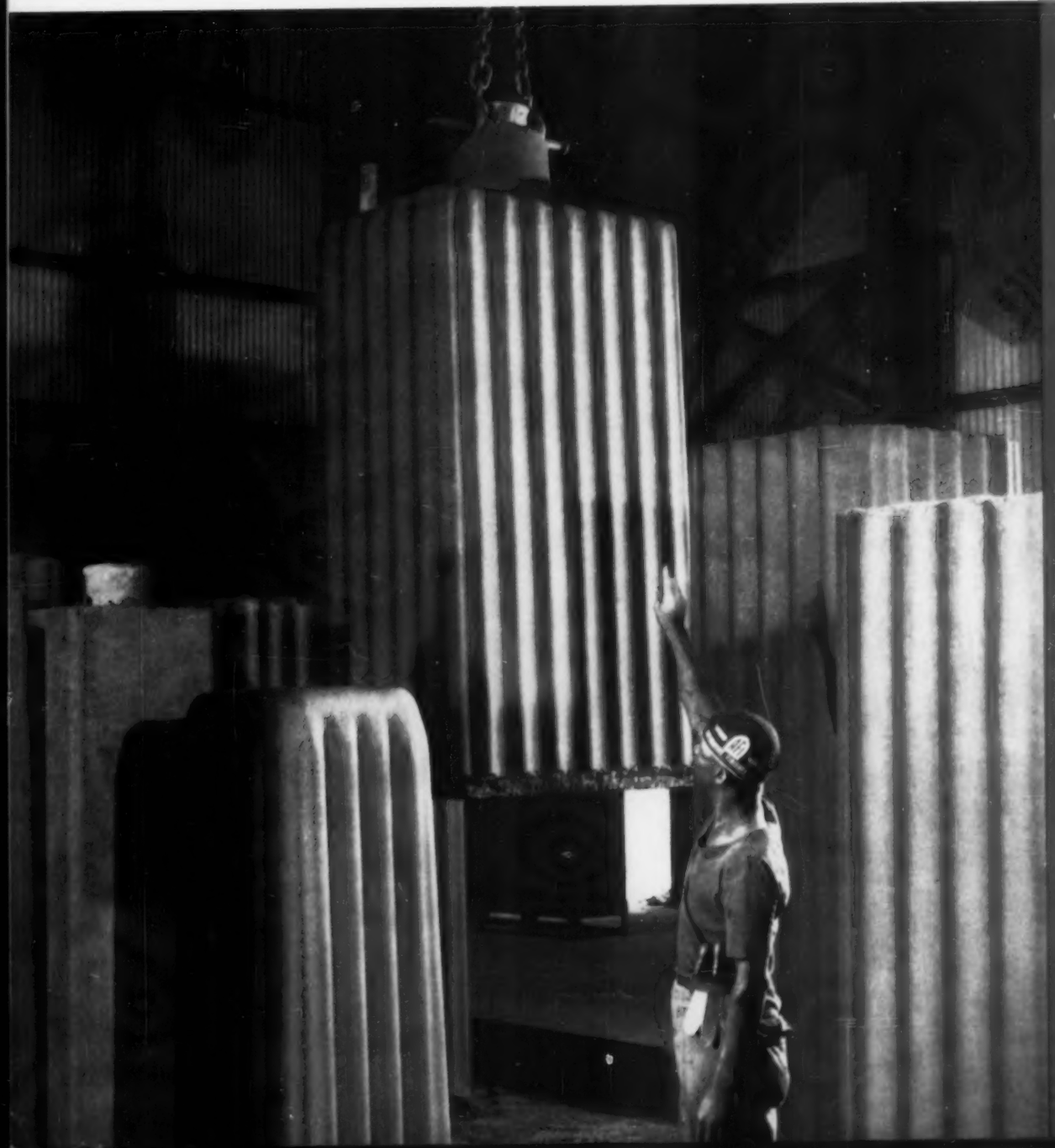
modern castings

and American Foundryman

NOVEMBER, 1955



Owned by THE MEN WHO BUY

In the Heart of a Mold

Here's how to use a microscope to identify and analyze molding materials

Vertical Gating Gets New Look

Helpful hints on reducing aspiration and turbulence, and trapping dross

Do Your "Short Order" Prices Hurt?

They're almost certain to if you don't increase them as your runs get smaller

How to Save $1/2 Million

A company made this saving on a single part by using high strength castings

How to Heat Treat Grey Iron

Four methods will help castings do a better job of meeting today's demands

4% Carbon Shot Controls Melt

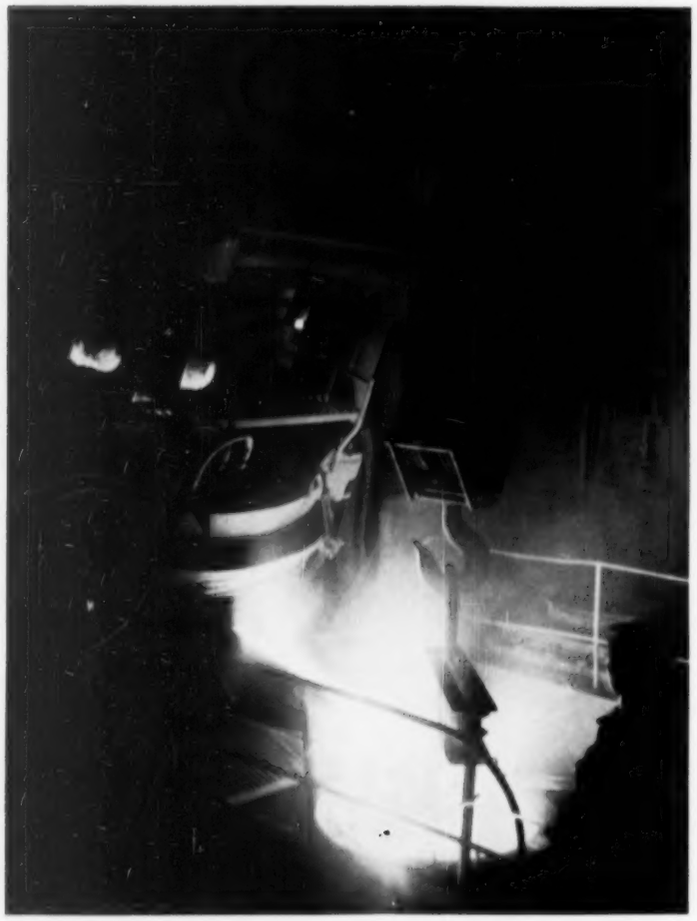
Pre-alloyed shot can have special advantages for investment casting

SPECIAL CUPOLAS

12-page bonus section on cupolas and accessories tells how to help solve new castings problems

"We can get heats out *fast* with our LECTROMELT FURNACE",

Says **Mr. L. A. Howell,** *Supt. Foundry Division*



SPEED is an important factor with this 3-ton Lectromelt Furnace. Although used principally on stainless steel alloys, it is also called on to produce feed metal in a hurry for two large furnaces on mild steels. It gets a heat out fast and then, within an hour and a quarter, another heat is ready.

Close control possible with Lectromelt Furnaces is, of course, important to the producer and user of castings alike. Holding temperatures and analyses within close limits results in better castings and cuts foundry costs. The user of those castings notes the difference by his reduced machining losses and finer finished products.

Whether you're working with iron, plain carbon or alloy steels, a Lectromelt Furnace will give you these advantages. For a free copy of Catalog No. 9-A describing these furnaces, write Pittsburgh Lectromelt Furnace Corporation, 316 32nd Street, Pittsburgh 30, Pennsylvania.

18,000-pound heats are made regularly in this PT Lectromelt® Furnace, installed in 1943 at Newport News Shipbuilding & Drydock Company.

Manufactured in . . . GERMANY: Friedrich Kocks GMBH, Dusseldorf . . . ENGLAND: Birlec, Ltd., Birmingham . . . FRANCE: Stein et Roubaix, Paris . . . BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege . . . SPAIN: General Electrica Espanola, Bilbao . . . ITALY: Forni Stein, Genoa. JAPAN: Daido Steel Co., Ltd., Nagoya

®REG. U. S. PAT. OFF

TWENTY FIVE POUNDS TO ONE HUNDRED FIFTY TONS CAPACITY

WHEN YOU MELT... MOORE RAPID *Lectromelt*

CIRCLE NO. 82, PAGE 79-80

future meetings and exhibits

NOVEMBER

1-3 . . Grinding Wheel Institute and Abrasive Grain Association, *Statler Hotel, Buffalo. Fall Meeting.*

1-3 . . Investment Casting Institute, *Sheraton-Cadillac Hotel, Detroit. Annual Fall Meeting.*

3 . . Malleable Founders' Society, *The Biltmore, New York. Eastern Sales Engineering Clinic.*

3-4 . . Metals Casting Conference, *Purdue University, West Lafayette, Ind. Sponsored by the Central Indiana and Michiana Chapter of AFS in cooperation with Purdue University.*

4 . . Malleable Founders' Society, *Hotel Commodore, New York. Eastern Section Meeting.*

11 . . Malleable Founders' Society, *Drake Hotel, Chicago. Western Sales Engineering Clinic.*

13-18 . . American Society of Mechanical Engineers, *Congress, Conrad Hilton, and Sheraton-Blackstone Hotels, Chicago. Diamond Jubilee Annual Meeting.*

14-17 . . International Automation Exposition, *Navy Pier, Chicago.*

16-18 . . Steel Founders' Society, *Hotel Carter, Cleveland. Annual Technical and Operating Conference.*

17-18 . . American Society for Quality Control, *Schroeder Hotel, Milwaukee. Tenth Mid-West Conference.*

18-19 . . New York State-Canada-Pennsylvania Regional Foundry Conference, Onondaga Hotel, Syracuse, N. Y. *Sponsored by Central New York, Eastern Canada, Eastern New York, Rochester, Western New York, Northwestern Pennsylvania and Ontario Chapters of the American Foundrymen's Society.*

DECEMBER

1-2 . . Michigan Regional Foundry Conference, *Michigan State University, East Lansing, Mich. Sponsored by the Detroit, Saginaw Valley, Central Michigan and Western Michigan Chapters of the American Foundrymen's Society and the Michigan State University*

and University of Michigan Student Chapters.

2 . . Malleable Founders' Society, *Drake Hotel, Chicago. Western Section Meeting.*

7-9 . . American Institute of Mining and Metallurgical Engineers, *Hotel William Penn, Pittsburgh. Electric Furnace Steel Conference.*

1956

JANUARY

20 . . Malleable Founders' Society, *Hotel Cleveland, Cleveland. General Society Meeting.*

23-26 . . Plant Maintenance & Engineering show, *Convention Hall, Philadelphia.*

FEBRUARY

9-10 . . Wisconsin Regional Foundry Conference, *Schroeder Hotel, Milwaukee. Sponsored by the AFS Wisconsin Chapter and the University of Wisconsin and the AFS Wisconsin Student Chapter.*

16-17 . . Southeastern Regional Foundry Conference, *Tutwiler Hotel, Birmingham, Ala. Sponsored by the Birmingham District and Tennessee Chapters and the University of Alabama Student Chapter of American Foundrymen's Society.*

24 . . Malleable Founders' Society, *Drake Hotel, Chicago. Western Section Meeting.*

27-Mar. 2 . . American Society for Testing Materials, *Statler Hotel, Buffalo. 1956 Committee Week.*

MARCH

2 . . Malleable Founders' Society, *Hotel Commodore, New York. Eastern Section Meeting.*

7-8 . . Foundry Educational Foundation, *Hotel Cleveland, Cleveland. College-Industry Conference.*

15-16 . . Steel Founders' Society of America, *Drake Hotel, Chicago. Annual Meeting.*

23 . . Malleable Founders' Society, *Drake Hotel, Chicago. Western Section Meeting.*

APRIL

12-13 . . Malleable Founders' Society, *Edgewater Beach Hotel, Chicago. Sev-*

. . . FOR BETTER SAND PREPARATION!

When it comes to preparing molding sand—there's no better way, no easier way, no more dependable way—than the Federal way! By simply adding Federal CROWN HILL SEACOAL, Federal GREEN BOND BENTONITE (pulverized or granular) and Federal SAND STABILIZER to your sand in varying amounts, all the important sand characteristics can be closely controlled and easily changed to satisfy specific requirements. You get *extra* advantages, too—lower cost, more uniform mold hardness, better shakeout, better finish and more readily saleable castings. Plus this mighty important fact—the three additives will cost you *less than $1.00 per ton of castings produced!*

There's a new Federal bulletin on the preparation of molding sand, that hundreds of foundrymen have found extremely helpful. A copy is yours for the asking. Write for it today!

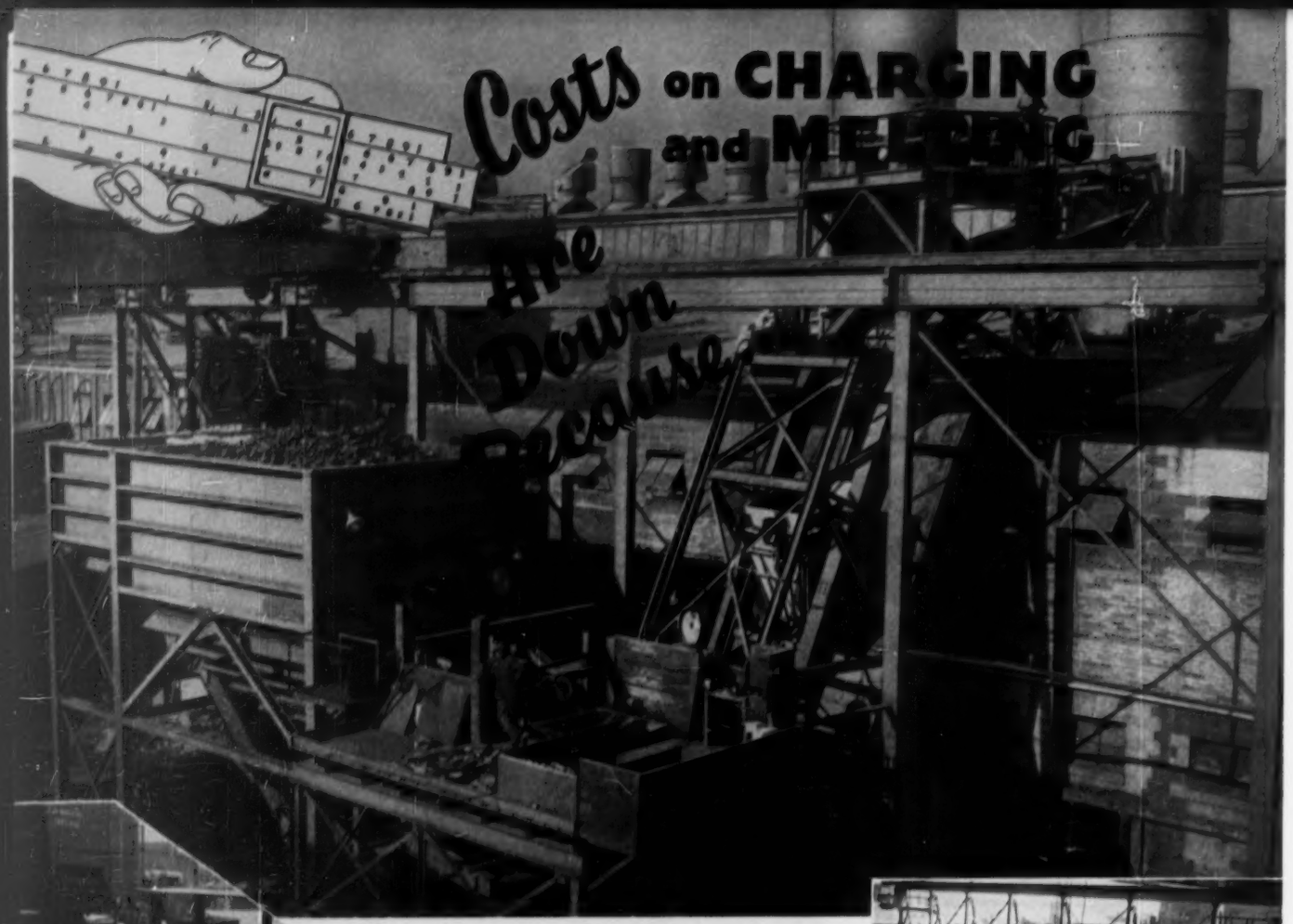
IMPORTANT
FOR SLURRY USERS!

If you use the slurry system of sand bonding, you'll want to learn about Federal's #1200 Slurry Grade, Granulated Green Bond Bentonite . . . and how it's used with Crown Hill Seacoal and Federal Sand Stabilizer to make the perfect slurry. We'll gladly consult with you or send complete information.

FEDERAL

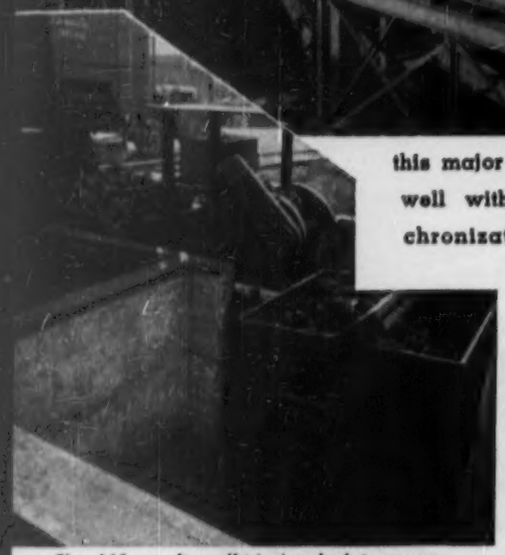
Make your foundry a better place in which to work!

The FEDERAL FOUNDRY SUPPLY Company
4600 EAST 71st STREET CLEVELAND 5, OHIO

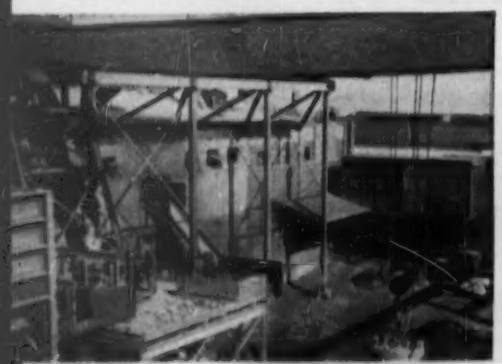


this major producer* of castings has planned well with MODERN engineers in the synchronization of every handling operation:

*Lakey Foundry Corporation, Muskegon, Michigan is a major producer of grey iron castings for the automotive, agricultural and household appliance industries.



The 165 cu. ft., self-tripping bucket conveys coke and stone, by crane, from car unloader to bin and batch larry. Scrap and pig are charged directly into the weigh hopper.



All components flow mechanically from gondola cars, through MODERN 108" cupolas, to the molds on the pouring floor. Undercar unloaders . . . coke and stone buckets . . . bins . . . hoppers . . . scales . . . MODERN Small-Cone charging bucket . . . inclined-swivel charger and the melting equipment team together to pull down costs while boosting the over-all quality.

Much of this controlled, time-proved mechanization is described in bulletin S-147-B. A note on your letterhead will start our thinking about ways to cut your costs RIGHT NOW while we're planning together for tomorrow's expansion . . .

MODERN EQUIPMENT COMPANY
Port Washington, Wisconsin

enth Market Development Conference.

27 . . Malleable Founders' Society, *Drake Hotel, Chicago. Western Section Meeting.*

MAY

3 . . Non-Ferrous Founders' Society, *Atlantic City, Annual Membership Meeting.*

3-9 . . American Foundrymen's Society, *Convention Hall, Atlantic City, N. J. 60th Annual Convention and Exhibit.*

11 . . Malleable Founder Society, *Hotel Commodore, New York. Eastern Section Meeting.*

JUNE

5-8 . . Materials Handling Institute, *Public Auditorium, Cleveland. Materials Handling Exposition.*

11-12 . . Malleable Founders' Society, *The Homestead, Hot Springs, Va. General Society Meeting.*

17-22 . . American Society for Testing Materials, *Chalfonte-Haddon Hall, Atlantic City, N. J. 59th Annual Meeting.*

SEPTEMBER

1-9 . . International Foundry Congress, Düsseldorf, Germany.

Start GIFS Safety Survey

For a new safety program undertaken by the National Safety Committee of the Gray Iron Founders' Society, approximately 2300 questionnaires were mailed to both jobbing and captive foundries of the gray iron castings industry. Object of the survey is to reduce both the frequency and severity rate of accidents in the industry.

E. W. Burne, General Electric Co., Schenedtady, N. Y., is chairman of the committee. Other members include: H. E. Bromer, Decatur Castings Co., Decatur, Ind.; W. R. Pritchard, Zenith Foundry Co., West Allis, Wis.; H. M. Heuer, National Motor Castings Div., Campbell, Wyant & Cannon Foundry Co., South Haven, Mich.; and Emil Oltean, Forest City Foundries, Cleveland.

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vol. 28 no. 5

modern castings

and American Foundryman

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TIPS, TRENDS AND TECHNIQUES

Sand cores for ingot molds shown on the cover determine the shape of ingots to come in the Braddock (Pa.) plant of U. S. Steel Corp. Ingot pouring and welding are two of the three forms of casting. The other, of course, is casting as it is practiced throughout the industry that provides the shortest distance from raw material to finished product.

Gray iron constantly comes up against increasingly rigid industrial demands which it satisfies through closer control of quality and through improved properties. One way to broaden the property range is to heat treat and you'll find the fundamentals starting on page 30.

Another move to meet new customer demands is the special melting techniques possible with cupola equipment described in this month's Bonus Section. The information was compiled by the late Gosta Vennerholm, manufacturing research manager, Ford Motor Co., for the American Foundrymen's Society's "Handbook of Cupola Operation."

Investment casters use small furnaces which are not as handy for building up heats as are the larger units used by sand foundries. One shop overcame its melting problems by using metal shot for melting stock (pages 34-35).

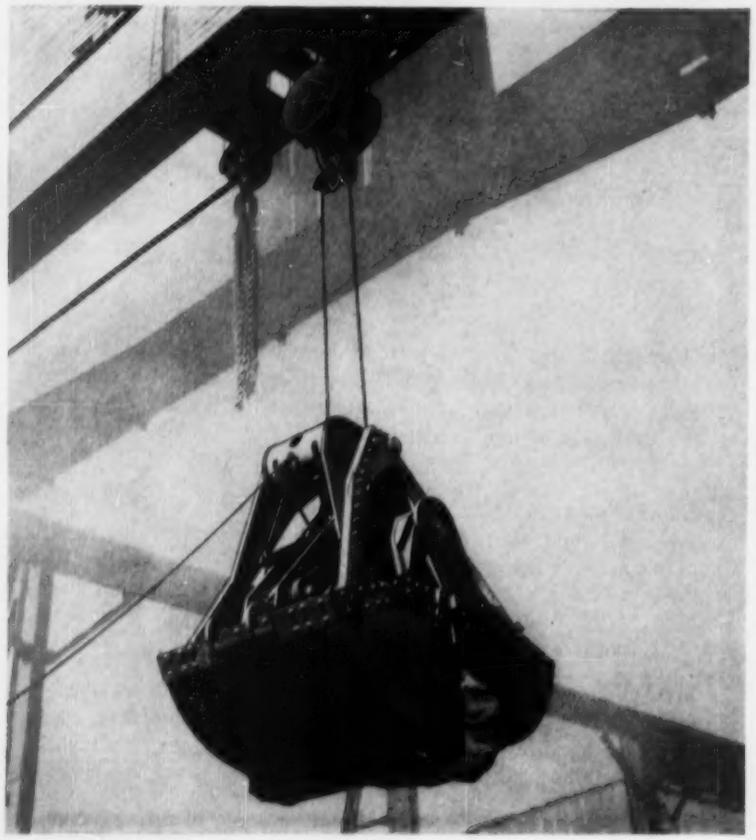
Your suppliers sell to you on a sliding scale of prices which vary with the quantity purchased, so why shouldn't you sell castings the same way? You should, and you can read how—and what you're doing to your company if you don't—on pages 53-54.

Gating practices so successfully developed by means of the transparent mold-water technique have been expanded to include vertical as well as horizontal systems. For the latest information that you can apply to sand, shell, or metal molds, see pages 55-56.

Study of mold materials has advanced considerably from the squeeze-a-handful test that many of us still apply every time we get near a heap of sand. Too little used is the microscope which can be a powerful tool if you want to take advantage of it (pages 58-62).

In December: evaluation of casting processes . . . solution to a non-ferrous melting headache . . . progress in coke evaluation . . . the Navy's new alloy . . . what to do in a flood . . . what to expect of equipment.

MORE WORK . . . FASTER!
WITH ERIE STRAYER HOOK-ON CLAMSHELLS



CHECK these exclusive features:

- √ EASY HOOK-ON—no changeover problem. Versatile.
- √ COMPACT, RUGGED DESIGN—longer, tougher service.
- √ LIMITED HEADROOM REQUIREMENT—made for tight spots.
- √ ALWAYS UNDER PERFECT CONTROL—eliminates shock.
- √ ¼ TO 10 YARD CAPACITY—models to suit your needs.

THE FAMOUS STRAYER ELECTRIC BUCKET
ALSO AVAILABLE FOR AC OR DC OPERATION

For Catalogs and General Information, Write:

ERIE STRAYER CO.
GEIST ROAD • ERIE, PENNSYLVANIA

CIRCLE NO. 84, PAGE 79-80

products and processes

CO_2 Binder

DonCO_2 is a new binder to be used with the Carbon Dioxide Process of making cores and molds. Problems of handling, flowability, gassing speed, strength retention, and core knockout

have been provided for in the formulation. Brochure describes the process and recommends procedure, sands, and auxiliary materials such as pastes, daubs, and washes. *Brumley-Donaldson Co.*

CIRCLE NO. 1, PAGE 79-80

Pocket Scriber

A new Pocket Scriber that looks and operates like a ball point pen has a point that extends at the push of a button in the cap. It retracts safely into the barrel when the pocket clip is depressed. Always available when carried with the pocket pen or pencil. *Lufkin Rule Co.*

CIRCLE NO. 2, PAGE 79-80

Pneumatic Chisel

Newly designed Delaware SN pneumatic chisel shank has greatly increased cross-section, lacks sharp corners, is as strong as the chisel body itself—allowing the chisel to be worn to a nubbin

without fear of shank breakage. Efficiency is increased as full power is delivered to the cutting edge. *Delaware Tool Steel Corp.*

CIRCLE NO. 3, PAGE 79-80

Drum Handling Attachment

The Liftomatic Junior is a drum handling attachment for hand propelled fork trucks and portable stackers with removable forks or platforms, of either the outrigger or counter-weight type. Will handle any drum, open or closed, fibre or steel, regardless of diameter or height, up to 1000 lb. Permits transportation, storage, and tiering without pallets. *Marvel Industries, Inc.*

CIRCLE NO. 4, PAGE 79-80

New Abrasive Wheel

A special safety web backing of spiral wound rayon auto tire cord, imparting extra strength and safety to high speed abrasive wheels, has been incorporated into new Simex Red Wheels. These

lightweight, rigid, reinforced resinoid-bonded abrasive wheels are used on portable disc-type and right angle-type portable grinders for rough production grinding of flash and welds. *Simonds Abrasive Co.*

CIRCLE NO. 5, PAGE 79-80

Light Mechanical Conveyors

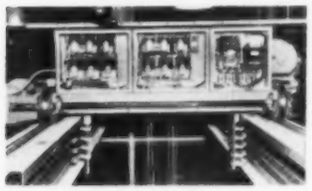
The addition of a light weight mechanical vibrating conveyor to the Jeffrey line meets the growing demand for inexpensive, dependable, and low maintenance conveying. The LMV is built in 12 ft sections with deck widths from 5 to 24 in. Height from floor is 14 in. max. Compact in design easy to

install, simple to operate, and quiet in operation, it handles a wide range of materials—those with good conveyability, up to 45 tons per hour. *Jeffrey Mfg. Co.*

CIRCLE NO. 6, PAGE 79-80

Crane Control

Newly developed light industrial crane control can save up to six times its cost a year per crane. Designed to replace the cab with a pendant operation



on infrequently used cranes, advantages include flexibility, inexpensiveness, and ease of maintenance. Control is available for both AC and DC and is adaptable for cab operation. *Westinghouse Electric Corp.*

CIRCLE NO. 7, PAGE 79-80

Machine Leveling Mount

New, double-function leveling mount not only permits quick and easy leveling without lagging to the floor, but it also reduces transmission of machine noise, shock and vibration. It consists

of a metal plate with an Isomode Pad cemented to it, a threaded bolt, flanged leveling nut and lock-nut. Loads range from 100 to 12,000 lb per mount. *MB Mfg. Co., Div. of Textron-American, Inc.*

CIRCLE NO. 8, PAGE 79-80

Core Coating

Red-Skin Core Coating, a new, non-drip, carbon-free core wash for all metals is said to penetrate deeply into the core while depositing a very uniform surface coating to prevent "burn in".

Conversion to Castings

THE NEW, BIGGER MARKET FOR FOUNDRIES!

By simplifying and redesigning existing parts so that they can be cast, aggressive foundries are converting more and more new users to low cost castings. By showing cost cutting advantages to their prospects they are building a whole *new* business for themselves.

Here's a typical example from one foundry:

This part was originally designed as a fabricated assembly, with numerous sub-parts. The foundry redesigned and engineered it as a one-piece steel casting. The result is a stronger part, with more eye appeal and better distribution of metal. *Yet it costs 28.2% less*, delivered as a complete unit, machined and painted.

BEFORE REDESIGNING

AFTER REDESIGNING

In such conversions we can be of real help. Here are just two of the ways Magnaflux can help you get more business by conversion.

First . . . Stress analysis with Magnaflux' Stresscoat* helps you to quickly design castings of exactly the right characteristics for a particular job. By showing stress in parts quickly and positively, Stresscoat insures castings with even stress flow. These are easier to pour, lighter, stronger and better looking.

Second . . . Intelligent sampling inspection with Magnaflux* helps you turn out better castings at lower cost. Magnaflux finds *all cracks* in pilot runs. It helps you determine *why* and *where* cracks occur—whether they are serious—and how to correct the cause before parts are run in quantity and later rejected.

** Magnaflux and Stresscoat are registered trademarks of Magnaflux Corporation*

Ask to have a Magnaflux engineer give you further facts and figures.

Photos and Data Courtesy of Superior Steel and Malleable Castings Co. Benton Harbor, Michigan

MAGNAFLUX CORPORATION

7352 West Lawrence Avenue, Chicago 31, Illinois

New York 36 • Pittsburgh 36 • Cleveland 15 • Detroit 11

Dallas 19 • Los Angeles 58

CIRCLE NO. 85, PAGE 79-80

Bulletin F-128 says there are no run-downs, tear-drops, or build-up, thus allowing faster dipping with no scraping or cleaning afterwards. *Frederic B. Stevens, Inc.*

CIRCLE NO. 9, PAGE 79-80

Aluminum Coating

New cold chemical finisher, Alumblack, gives aluminum a dull gloss finish if left unrubbed, or a high-gloss, finish if rubbed. Dries in one minute. May be dipped, sprayed, or applied with rag or brush. Penetration avoids measurable tolerance deviation. Company is glad to send sample kits and cooperate in determining specific applications. *Birchwood Chemical Co.*

CIRCLE NO. 10, PAGE 79-80

Filter Inspection Speeded

Improved Day "AC" Reverse Jet (Hersey-type) Dust Filter has a new housing with walk-in access door and two inspection doors that speed inspection and allow maintenance or repairs to be made with greater ease and in less time. Bulletin 559 available. *Day Co.*

CIRCLE NO. 11, PAGE 79-80

Special extra length Thermocouple shown at right. Write for price list.

At left are shown standard Ladle and Furnace type Marshall Thermocouples.

"YARDSTICK TO CASTING QUALITY"

In nonferrous casting, temperature of molten metals must be measured often to assure solid, good quality castings.

Here is where Marshall Enclosed-Tip Thermocouples safeguard your foundry operations. They report metal temperatures quickly, accurately, thus assuring that castings are poured at exactly the right heat.

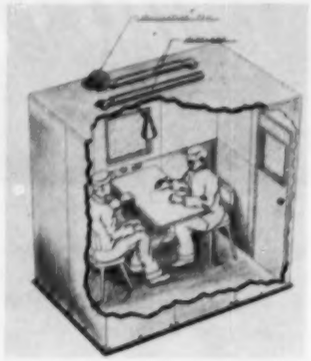
Your foundry probably is already using Marshall Thermocouples. They're in use throughout U.S. and Canada. Thermocouples come in Ladle and Furnace types. Also obtainable in special extra lengths. Send for descriptive literature. L. H. Marshall Co., 270 W. Lane Ave., Columbus 2, O.

Below . . Taking temperature of a heat of copper-beryllium alloy

CIRCLE NO. 86, PAGE 79-80

Pre-Fab Sound-Proof Room

A sound-proof room for shop office telephone room, etc., or for audiometric testing is completely pre-fabricated, quick to assemble, and because of its



modular construction, is readily expandable by adding pre-fab sections. Room is well lighted and ventilated and comes equipped with an adjustable table. *Kittell-Lacy, Inc.*

CIRCLE NO. 12, PAGE 79-80

Castings of Match-Plate Metal

As a match-plate metal, Salloy aluminum alloy produces an extremely bright surface. It is close grained and takes a good polish. While the cost of Salloy is higher than standard aluminum alloys, the results obtained and reduction of rejects actually mean less overall cost for some finished products. *George Sall Metals Co.*

CIRCLE NO. 13, PAGE 79-80

Soldering Flux

For those who have only occasional use for soldering flux La-Co Flux (Regular) is available in new 2-oz can. This self-cleaning, non-acid flux can be used

with 40-60, 50-50, 60-40, and 95-5 solders for a wide variety of work. No wire brushing or sanding is necessary. *Lae Chemical Co.*

CIRCLE NO. 14, PAGE 79-80

Pressure Gauge Tester

Periodic checking of pressure gauges is necessary to secure proper and safe operation of equipment. Amthor Dead Weight Pressure Gauge Testers are sturdy, modern, and compact, portable, easy to operate, and accurate within 1/10 of one per cent of the indicated reading. Literature available. *Amthor Testing Instrument Co., Inc.*

CIRCLE NO. 15, PAGE 79-80

Operation Monitor

New feature of the Time Recorder-Totalizer is that a counting device can be used in place of the time totalizer for determining the number of operations or pieces produced or processed by machines. Bulletin says this precision instrument acts to reduce down time and to lower production costs. *Standard Instrument Corp., Div. of Heat-Timer Corp.*

CIRCLE NO. 16, PAGE 79-80

Wrap-Around Face Mask

The Scottoramic face mask offers amazing visibility with wrap around windshield which does away with the two separate "peep-hole" eye-pieces. Dispells feeling of claustrophobia. Cool

air or oxygen supply assures non-fogging. Plastic safety lens is virtually unbreakable. Comfortable when worn a long time—even over glasses. May be donned with one hand. Microphone and air hose optional. *Scott Aviation Corp.*

CIRCLE NO. 17, PAGE 79-80

Infrared Lenses

Germanium and silicon lenses are now available for use in infrared optics. Because of high refractive indices, single elements have appreciably less aberration than glass lenses of equal power. Lenses may be anti-reflection coated to provide transmittance of over 90% for

the spectral region of interest. Technical Circular RD 516. *Baird Associates, Inc.*

CIRCLE NO. 18, PAGE 79-80

Silencer

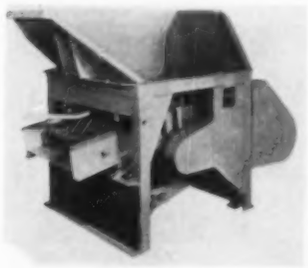
Quietaire Pneumatic Silencers are all-metal units added to industrial air-operated equipment to reduce sound in noise-shock areas to nearly the level of the average factory (75 decibels). Tests show that operating efficiency is in no way impaired while noise is

dampened. Unit has no cartridges, no parts that need replacing. Bulletin. *C. W. Morris Co.*

CIRCLE NO. 19, PAGE 79-80

Screen and Separator

New Screenmaster, self-contained return sand screening and separating unit, is designed for floor use and has an adjustable lump breaker. Rated at 50 ton/hr, it has a 30 cu ft hopper, 30 x 60-in. screen, and radial-type magnetic pulley for tramp iron removal.



Screen and conveyor units are protected from undue wear from abrasive elements. No obstruction at floor provides for ease of maintenance and clean-up. Bulletin 525. *National Engineering Co.*

CIRCLE NO. 20, PAGE 79-80

Geiger-Mueller Counter

Menlolab Mark VII Survey Meter for beta and gamma radiation is an all-new, popularly priced, portable geiger-mueller counter with separate light weight probe. The 0.01 mr/hr sensi-

Put the brakes on heat-checking

...or how Chuck Wright "beat the drum" for increased strength

"Ever watch a heavily-loaded truck and trailer combo slither down a steep long road?" asked Chuck Wright.

"One look," the INCO distributor foundry specialist continued, "tells why brake drums on heavy trucks can get red hot.

"Some months ago, Bruce Benson, superintendent of the Lenox Foundry, wired me to come on the double. He'd been pouring brake drums for years. Lenox drums . . . typical medium grade iron of some 3.30 carbon, 1.80 silicon and a little alloy . . . gave good, long service on light trucks.

"Bruce couldn't account for the failures that followed his use of the same iron in thicker, larger drums for heavy-duty vehicles. Particularly since his foundry practices were the best.

"Failure of the drums resulted from heat-checking, I explained to Bruce. Because on heavy-duty trucks, brake drums sometimes get red hot. At these temperatures the iron goes through what metallurgists call the *critical range* . . . where a sudden contraction of the expanding metal takes place. Repeated cycles of this cause heat-checking of the drum surface. Eventually, it becomes so rough that the shoe is chewed up and the brake fails. In fact, the drum casting may even crack in two.

"But you can combat heat-checking, as I told Bruce, by using a high graphite iron, carbon at least 3.60%. This amount allows the metal some leeway as it expands and contracts. At the same time, to keep a balanced iron, silicon should be reduced to a maximum of 1.40%.

"Reducing silicon will give the iron a tendency to develop chills and brittleness. However, you can curb this trend by adding 2% nickel.

"Although such a composition will answer the heat-checking problem, it won't provide high enough tensile for heavy-duty service. So you add 0.35% to 0.50% each of molybdenum and chromium. The additions of moly and chrome help to develop not only proper strength but they also help to lessen the expansion-contraction rate of the iron in the *critical range*.

"Those were my suggestions to Bruce Benson, and he followed them.

"Since then, Lenox heavy-duty drums have come through every sort of test in the lab and on the road with colors flying. Warping is minimized, and the drums not only resist wear, but also keep their uniform round shape.

"Don't wait until a customer complains before calling me for help. When you need some practical answers, where the metallurgy of castings is involved, I'm your man. And the easiest way to reach me is through INCO."

Chuck Wright

The International Nickel Company, Inc.

67 Wall Street New York 5, N.Y.

INCO

NATIONAL
HYDRO-FILTER
stops dust here!
Unique turbulent area assures positive dust collection at constant efficiency . . . to the micron range

Here is the "heart" of the Hydro-Filter principle of dust separation. This violently turbulent area of water, bubbles and mist is produced by the countercurrent action of air against water. Constant long contact between the air being cleaned and the water which is doing the cleaning produces a scrubbing action which is positive, thorough and unaffected by variation in volume and velocity of flow. Dust is entrained by any, or all, of three means: (1) Entrapment within falling water droplets; (2) Impingement on bubble surfaces; (3) Impingement on wetted surface of glass spheres.

As the photo indicates, the entire collection area is continually flushed. There are no dead areas to corrode or erode. No moving parts to "load up" and reduce efficiency. Maintenance is a matter of *minutes a month*. Collection of dust to micron size is continuous and sludge removal automatic with the National Hydro-Filter.

Write for Bulletin 55 . . .

See why and how separating efficiencies of up to 98.9% on foundry shakeout dust are possible practical — and continuous with Hydro-Filter!

NATIONAL

Dust Collector Corp.

601 Machinery Hall Bldg., Chicago 6, Illinois

Subsidiary of National Engineering Company, Manufacturer of Simpson Mix-Mullers.

CIRCLE NO. 87, PAGE 79-80

tivity with ranges of x1, x10, and x100 are kept in calibration by the radium standard supplied with the instrument and the readily accessible external calibration control. Electronic tube oscillator. Weighs only 4½ lb complete with batteries, measures 7x4x3 in. *Menlo Research Laboratory.*

CIRCLE NO. 21, PAGE 79-80

Ratchet Lever Hoists

Coffing's Super Power Coil Chain Ratchet Lever Hoists are said to have 85 per cent efficiency taking only 74 lb to lift 5 tons. They are compact—patented compound levers take less room than gears. 5-ton model weighs only 56 lb. The fewer parts are larger in size with safety factor of five in load-holding parts. *Coffing Hoist Div., Duff-Norton Co.*

CIRCLE NO. 22, PAGE 79-80

Wide-Angle Face Shield

M-S-A Skullgard-Faceshield is a clear acetate visor with excellent frontal and side protection. It can be attached to

any M-S-A protective hat without marring the hat. Installed or removed in seconds. May be pivoted to any position. Bulletin 0302-4. *Mine Safety Appliances Co.*

CIRCLE NO. 23, PAGE 79-80

Cut Off Wheels

The new B7 bond line of Aloxite aluminum oxide resinoid cut off wheel combines desirable qualities essential to dry metal cut off operations. Sharp sides prevent binding. Available in 24 to 120 grit. Wheel sizes from 6 to 20 in.; 1/16, 3/32, and 1/8 in. thick. *Carborundum Co.*

CIRCLE NO. 24, PAGE 79-80

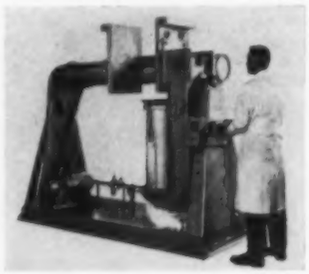
High-Speed Potentiometer

The High-Speed Electronic Dynamaster is a recording wide-strip potentiometer featuring full-scale pen travel in only 0.4 sec. Pen traverses 11-in. scale without overshooting. "Deadband" is less than 0.1% of full-scale span. Ranges are as low as 1 mv for full scale, with source resistance up to 10,000 ohms. *Bristol Co.*

CIRCLE NO. 25, PAGE 79-80

Giant Shell Core Blower

Shalco's 7 ft high Model MCM-6 will take core boxes 36 in. long. Box halves are mounted on electrically heated cast iron plates which are opened and closed by electric gear motors. Sand is

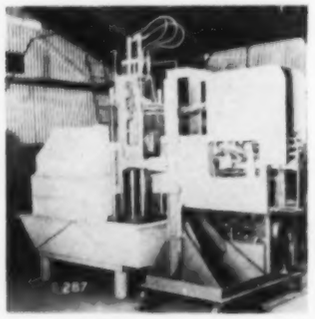


blown into the box, the unit is inverted to return excess sand to the blowhead. After a short period, the box opens and the finished core is removed. Production rate is about one cycle per minute. *Shallway Corp.*

CIRCLE NO. 26, PAGE 79-80

Automatic Slug Caster

Stroman Automatic Slug Caster, with potential output of 2000 to 3000 pieces of aluminum per hour, has a pan and a water-cooled mold, both of which enter the furnace well. Aluminum enters the mold through a gate in the pan. After cooling, the pan and mold



shift to shear the solidified gate, then both rise from the metal, and separate, permitting the slug to be ejected. *Stroman Furnace & Engineering Co.*

CIRCLE NO. 27, PAGE 79-80

Plastic Refractory

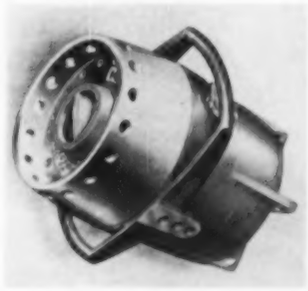
Narcoline is a plastic refractory for ladles spouts, and cupolas, ferrous and non-ferrous practice. It is made of dried and ground fire clay combined with graphite. Bulletin says it is ex-

tremely resistant to thermal shock, is easy to install and easy to clean of adhereing slag and ballast. Available in a wide workability range for installing with air hammer or by hand. *North American Refractories Co.*

CIRCLE NO. 28, PAGE 79-80

Gamma Ray Projector

Model CA Kel-Ray gamma ray projector weighing only 2,900 lb is designed for optional mounting on a mobile rig.



Cart mounted or hoist mounted, it has been used in the center of activity of a factory without hindering production in any way. Projector is equipped for both spot and panoramic shots. A 75-lb and a 250-lb model are also available. *Nuclear Products Div., W. Kellogg Co.*

CIRCLE NO. 29, PAGE 79-80

Dust Filter

Six "throw-away" after-filters have been incorporated in the Torit 219 FM-A cyclone-type dust collector. By returning air to the room, heat loss is prevented during cold weather. 5-hp, 3450

rpm motor pulls 2100 cfm through 8-in. inlet at static pressure of 3.0 in. (water) and air speed of over a mile a minute. *Torit Mfg. Co.*

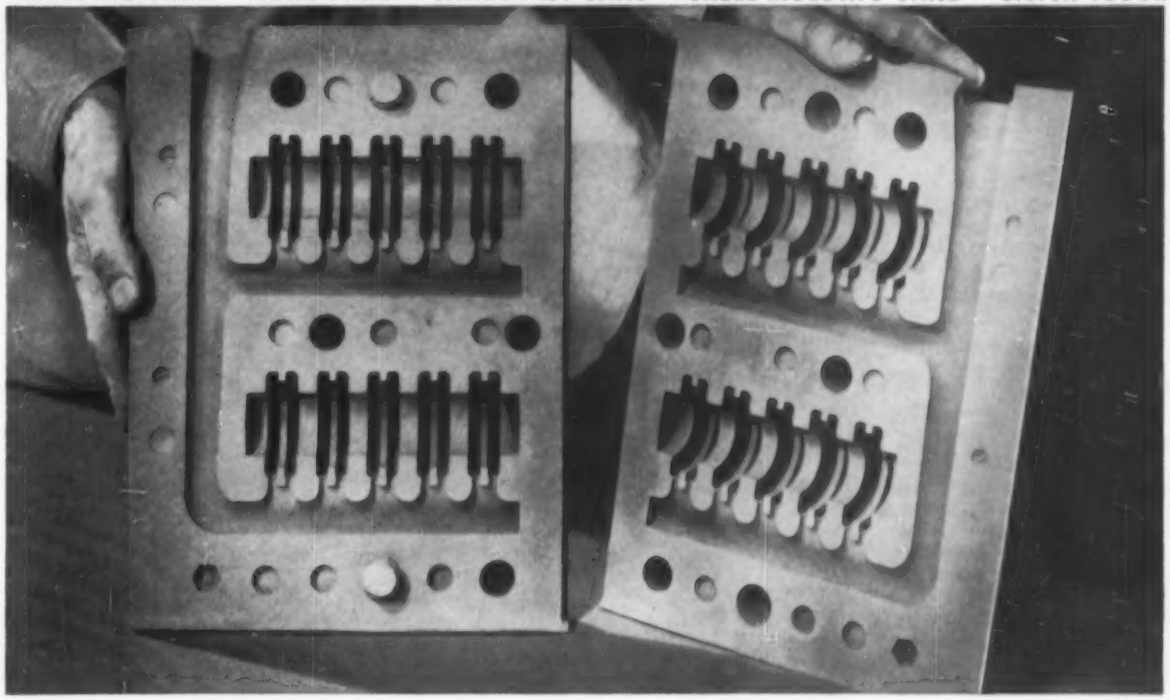
CIRCLE NO. 30, PAGE 79-80

Industrial Paper Wipers

A new type of industrial paper wiper has been specially designed to meet the general wiping needs of industry.

Quality Silica Products . . . since 1868

MOLDING SAND • CORE SAND • SANDBLAST SAND • SHELL-MOLDING SAND • SILICA FLOUR



You can't do better than the best...

Shell-Molding PENN-SAND

The best in the foundry is the sand that can be depended upon to produce the most flawless castings, time after time. Here's how Shell-Molding PENN-SAND can give you consistently better castings at low cost:

WIDE SCREEN DISTRIBUTION
—results in castings of exceptional finish, gives excellent permeability, eliminates gas problems.

LOW CONFINED EXPANSION
—aids mold stability, reduces rejects.

HIGH REFRACTORINESS
—facilitates pouring, prevents surface defects.

ABUNDANT SUPPLY
—insures immediate shipment of your orders.

LOW COST
—priced economically for bulk and bagged shipments.

For further information and free samples, fill out and return the coupon below. And remember—PENN-SAND is the sure start to a *perfect* finish.

PENN P.G.S. SAND

THE SURE START TO A PERFECT FINISH

PENNSYLVANIA GLASS SAND CORPORATION
TWO GATEWAY CENTER
PITTSBURGH, PENNSYLVANIA
Please send me, without obligation, samples and more details on Shell-Molding PENN-SAND.

NAME .....

FIRM .....

STREET .....

CITY ..... ZONE..... STATE.....

CIRCLE NO. 88, PAGE 79-80

Each wiper consists of two "Perf-Embossed" sheets which have been chemically treated for all important wet strength. Wipers come 125 to the "pop-up" box. *Scott Paper Co.*

CIRCLE NO. 31, PAGE 79-80

Stackbins

King size palletized stackbins, designed for more efficient bulk parts handling and storage, are useful as intra or inter-departmental carrier for heavy small parts or irregularly shaped materials. Hopper front keeps contents visible at all times and easily accessible for inventory and further processing purposes. *Stackbin Corp.*

CIRCLE NO. 32, PAGE 79-80

Ferrous Materials Tester

The Magnetic Comparator provides a non-destructive, quick, simple method of testing ferrous parts for quality. Parts can be compared with a preselected standard to detect a difference in composition, heat-treatment, or other characteristics which alter the resistivity or magnetic properties. A testing rate up to 1200 pieces an hour is possible. Parts are tested by insertion in electric coils, available in various sizes, or through the use of gage heads placed on larger pieces. A meter indicates deviation from the preselected sample. Descriptive material is available. *Sunshine Scientific Instrument.*

CIRCLE NO. 33, PAGE 79-80

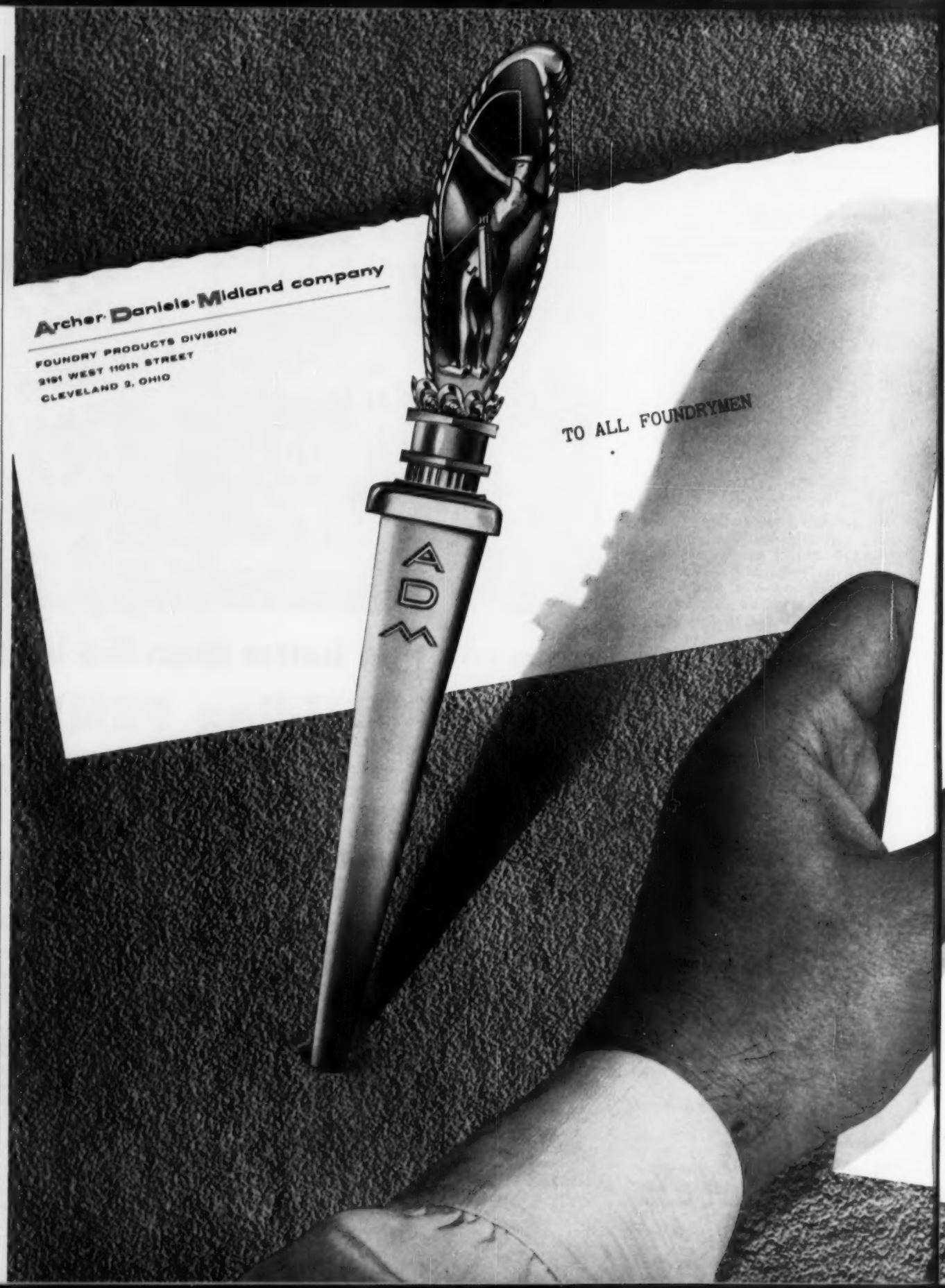
Left-Hand Wire Thread Inserts

Stainless steel wire thread inserts in Shop-Pack units are available for industrial equipment repair. Inserts come in the 7/16-20 and 1/2-20 sizes. The use of inserts replaces other methods of thread repair such as tapping oversized threads for large screws; weld, redrill and retap; and the use of bushings. Only three steps are required: (1) drill out the damaged threads, (2) tap new threads to accommodate the insert, (3) screw in the insert. *Heli-Coil Corp.*

CIRCLE NO. 34, PAGE 79-80

Packless Solenoid Valve

New type of packless solenoid valve that utilizes line pressure to assist the solenoid in opening and closing the valve, has recently been introduced. The valve, called the type S, is designed for nominal pipe size opening. It may be applied to control automatically or from remote points the flow of steam, hot liquids and gasses not injurious to bronze, at fluid temperatures up to 400 F. An auxiliary operating piston, that is integral with the disc



Archer-Daniels-Midland company

FOUNDRY PRODUCTS DIVISION • 2191 WEST 110TH STREET

CLEVELAND 2, OHIO

OPEN LETTER TO ALL FOUNDRYMEN:

The next step to making better, more uniform, lower-cost cores is yours. ADM can help you. Here's how:

1) ADM makes all types of binders: urea and phenol synthetic resins, alkyds, D process and C process binders, numerous specific-purpose LINOILS and several fast-baking INDUCTOLS. Therefore, we can impartially prescribe the type that is right for your specific application.

2) ADM core binders can often cut your core oil costs 10c to 40c per gallon due to our completely integrated production.

3) With 26 ADM warehouses and manufacturing facilities in 6 locations, you get overnight delivery anywhere in the country.

4) ADM's field organization (the largest in the business) is always at your service.

If you want to make a good casting better...if you are especially concerned about quality or uniformity of cores, see your ADM LINOIL man. Call him today.

Sincerely,

ARCHER-DANIELS-MIDLAND COMPANY
Foundry Products Division

L. P. Robinson
Vice President

DM FOUNDRY PRODUCTS: LINOIL CORE OILS • INDUCTOL FAST BAKING CORE OILS • LIN-O-CEL SAND STABILIZER • FREFLO PARTING COMPOUND • ADMIREZ FOUNDRY RESIN

holder, assists the solenoid in opening the valve against higher line pressures. Additional information available. *Magnatrol Valve Corp.*

CIRCLE NO. 35, PAGE 79-80

Add to Fork Truck Line

A new, 6000-lb fork truck has been added to the FG line of "Balanced Design" gasoline-powered trucks by *Baker-Raulang Co.* Model FG-60 features 144-in. maximum lift, extremely short (85½-in.) turning radius, and low initial and maintenance costs. Other features include low center of gravity, self-equalizing hydraulic brakes, and low-pressure hydraulic system. There are two speeds forward and two in reverse, with top full-load travel speed of 7 mph at 1900 rpm.

CIRCLE NO. 36, PAGE 79-80

Pneumatic Refractory Rammer

Light-weight Vibron Refractory Rammer eliminates recoil and vibration, increases worker efficiency by reducing fatigue. It is also safer. Operating on usual shop air pressures on the highly efficient Vibron cycle, it uses little air. Normally supplied with a 3 in. diam. ramming head but can be equipped for any work requirement. Maintenance costs on heavy portable troughs, runners, and ladles can be reduced by applying greater density and longer life patches on the plant floor without moving the equipment to the repair shop. *Vibron Div., Burgess-Sterbentz Corp.*

CIRCLE NO. 37, PAGE 79-80

Electric Cable Hoist

Fully enclosed and compact DR Model 55 Electric Cable Hoist achieves exceptionally close headroom and a lifting speed of 25 fpm. Gears are permanently lubricated by type G Molykote molybdenum compound. Ball bearings have sealed-in lubrication. Hoist is push-button controlled. Load protection is by solenoid-operated motor brake and heavy-duty Weston-type friction brake. Capacities include ¼ and ½-ton at 110/220 or 220/440 volt and 1-ton at 220-440/volt. *David Round & Sons, Inc.*

CIRCLE NO. 38, PAGE 79-80

Pre-Engineered Conveyors

"Install-It-Yourself" conveyor units are described in new 20-page conveyor Catalog C-205 which tells when and where to use various types of wheel and roller gravity, belt, and live roll conveyors; how to figure systems, loads,

CIRCLE NO. 89, PAGE 79-80

Now, more than ever, you can depend on

HANNA

as your best source for

PIG IRON

- *Our merchant capacity is bigger than ever*
- *Our plant is better than ever*
- *Our product range is greater than ever*

The

HANNA 38-POUND PIG

The foundryman's favorite standard pig. Available in all grades, silvery and HannaTite. A good example of the quality that has made Hanna "the best known name in iron."

The New

EXCLUSIVE HANNATEN INGOT

For 10-lb.-pig users, this new ingot means no free-carbon pockets, finer grain structure, more even melting. Available in all grades, silvery and HannaTite—an extra-close-grain iron.

THE HANNA FURNACE CORPORATION

Buffalo • Detroit • New York • Philadelphia

Merchant Pig Iron Division of

NATIONAL STEEL CORPORATION

CIRCLE NO. 90, PAGE 79-80

power, etc. Slanted toward "when to use" rather than "what they are." *Lamson Corp.*

CIRCLE NO. 39, PAGE 79-80

Mold Spray

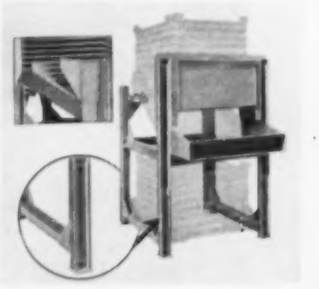
Mold spray Stevens Ignicoat was developed to eliminate lengthy torching of molds and tunnel oven drying. By mixing Ignicoat with isopropyl alcohol

and igniting, molds can be closed after a short burning time. Sprayed, brushed, or swabbed, Ignicoat produces smooth castings. *Frederic B. Stevens, Inc.*

CIRCLE NO. 40, PAGE 79-80

Drop-Bottom Box Stand

Positioning stand for drop bottom boxes has adjustable height control. Boxes are automatically unloaded when placed on the stand. Safety doors



on stand sides prevent parts fall-out. Handles a box for dumping, another for storage. *Palmer-Shile Co.*

CIRCLE NO. 41, PAGE 79-80

Submerged Cut-off Cooling

Metallurgical micro samples can be cut to size without burning or distorting the metal when using cooling attachment and No. 1000 Cut-off Machine. Cooling attachment holds samples up to 9½ in. long under water during cutting and at the same time applies jets of water directly to cut-off wheel. Device fills and drains automatically, permitting loading and unloading the vise out of the water. *Buehler Ltd.*

CIRCLE NO. 42, PAGE 79-80

talk of the industry

ALL THE FUSS about CO_2-water glass bonded molds and cores has caused some of us to forget that sodium silicate has been used for years as a binder in foundry operations, particularly for washes and refractories. In these cases its bonding power does not depend on silica gel formation as in the CO_2 process unless you want to count the effect of carbon dioxide in products of combustion during torch or fire drying. But heat and CO_2 aren't the only possibilities. Ever try pouring alcohol over a sodium silicate bonded core? Could use hydrochloric acid instead of alcohol but it's corrosive, so why bother when you can borrow some of the shellac thinner from the Pattern Shop.

CARPENTER they call him in the core room of the Cadillac Motor Car Div. foundry of General Motors Corp. Swinging his hammer, he assembles cores with nails and paste. Cores were formerly bolted at considerable cost in time and bolts. Holes only slightly smaller in diameter than the nails used—formed in the cores by pins in the blow boxes—grip the nails but are sufficiently large to avoid splitting the core.

MINOR FOOT AND ANKLE BURNS used to pose a problem for Dr. Stanley E. Anderson of Rockford, Ill. Foundry workers got their pressure vaseline dressings soaked in the shower and there weren't always nurses on duty at the plants to replace the dressings. Dr. Anderson's solution according to Industrial Medicine & Surgery: give the worker a vinyl plastic turkey-size bag to slip on at shower time, and a wide rubber band to hold it in place.

NEVER BRIGHTER is the way F. X. Bujold, manager of foundries, Ford Motor Co., put it in commenting on the outlook for the castings industry at the recent annual meeting of the Foundry Equipment Manufacturers' Association. And the potential for the manufacturer of foundry equipment is equally promising, he declared. He outlined what management expects of foundry equipment and included among numerous requirements: conservative factor of safety with clearly defined operational limitations; reasonable access for quick, easy maintenance with standard tools; machines that perform more operations automatically; reduced noise levels; improved ventilation; decreased vibration. It is the supplier's responsibility, Mr. Bujold stated, to see that his customer is properly trained in the use and maintenance of his equipment. He recommended sending foundry personnel to training schools and said that in all cases, operational and maintenance instructions should be provided with the equipment.

FOUNDRY CUSTOMER'S quality control program begins in the foundry according to Kenneth G. Cook, chief inspector of Thomas & Betts Co., manufacturers of electrical fittings. Three non-ferrous foundries cooperated with the company in controlling conductivity and machinability. Result was better castings and improved foundry

pouring off the heat

best foot forward

▪ This is to compliment you on the fine issues that are coming out in our MODERN CASTINGS monthly AFS magazine. But I've also got some constructive criticism.

In many of the advertisements, the foundry employees shown are generally dressed in as dirty clothing as can be found anywhere. I don't mean to say that they should be wearing a silk shirt and fancy tie, but at least they could have their face clean and wear a clean shirt and clean pair of pants.

To illustrate my point I have enclosed a number of ads from the September issue. I am sure you will see what I mean.

I notice that a number of advertisers take care in having proper clothing on their foundry operatives, while others seem to pay no attention to it. How about getting all of them to clean up their pictures?

WALTER L. SEELBACH, *President*
Superior Foundry, Inc.
Cleveland

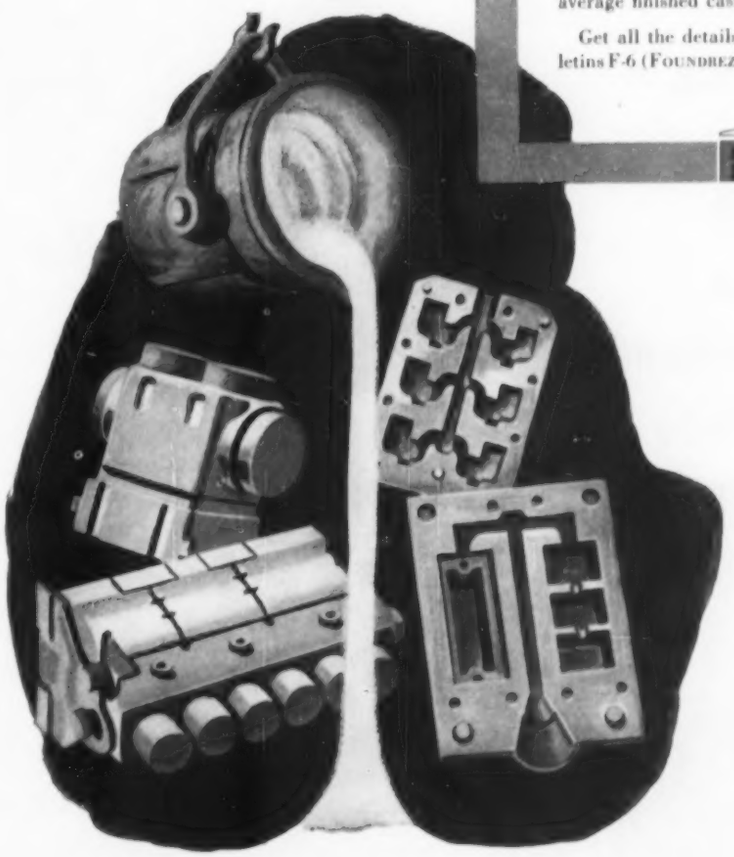
We're confident advertisers, like foundrymen, want to put the industry's best foot forward, and that they'll be glad to cooperate. We'll help by continuing to keep cleanliness, good housekeeping, and safe practices in mind in selecting editorial pictures.—Editor.

"almost no chain failures"

▪ We are very happy about the clearness of the various illustrations in *"No Chain Failures in This Foundry"* (August, pp. 62-65) and our article in general. The title, however, disturbs us. As every experienced foundryman knows, it is practically impossible to eliminate *all* chain failures. The human element is present in most handling operations, and human nature being what it is, we are sorry to give the impression that because of our program we never had or will have a chain failure.

We know that through our chain

For blowing smoother shells and cores, use RCI's liquid



• Now, thanks to FOUNDREZ 7429, you can get outstanding shell molds with a conventional blowing machine at a saving of 50 to 75% in resin. You cut overall shell mold production cost one half to one third with this liquid, water-soluble Reichhold phenolic resin. The shells equal or surpass the smoothness and dimensional accuracy of molds made by the "C" process, with its expensive special equipment.

Faster core blowing is the big reason for replacing core oils with RCI's other liquid, water-soluble, phenolic resin — FOUNDREZ 7581. It reduces the coring cycle from hours to minutes. Cores come out almost "pattern-smooth", making hand filing, mudding or core washing generally unnecessary. As the binder contains no cereal, there's less gassing and fewer rejects. Thus, FOUNDREZ 7581 saves you labor, which makes up about 35 to 40% of the total cost of the average finished casting.

Get all the details. Write for free Technical Bulletins F-6 (FOUNDREZ 7429) and F-5 (FOUNDREZ 7581).

RCI

Creative Chemistry . . .
Your Partner
in Progress

REICHHOLD

Synthetic Resins • Chemical Colors • Plasticizers • Phenol
Glycerine • Phthalic Anhydride • Maleic Anhydride • Sodium Sulfate
Sodium Sulfite • Pentaerythritol • Pentachlorophenol
REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N. Y.

CIRCLE NO. 91, PAGE 79-80

practice. One shop found its method of cleaning crucibles was ineffective when a trace of foreign element kept cropping up during analysis.

FAST TAX WRITEOFFS initiated by the Office of Defense Mobilization during the Korean mobilization are being curtailed or eliminated according to the National Foundry Association's weekly newsletter. The aluminum industry has been permanently cut off from further writeoffs. Also concerning foundries: (1) Expansion goals (estimated top limits on mobilization needs) have been closed for gray iron. This ends writeoffs; (2) Interior and Commerce Departments have been directed to re-examine the closed goal for pig iron; (3) No action on the steel castings goal pending further study.

THINK OF ANYTHING you wish in the way of control of industrial environment and you'll find recommendations in the safety, hygiene, and air pollution control publications of the American Foundrymen's Society. Local codes, of course, supersede these authoritative publications so it's wise to check with state and local regulatory agencies. You can get a list of state agencies to contact by writing to AFS Headquarters, Golf & Wolf Roads, Des Plaines, Ill.

SO-CALLED TRADE SECRETS which devotees of the various casting methods guard closely while fighting each other instead of developing new business slow the transition from art to science and alienate potential customers according to Hiram Brown, company chief metallurgist, Solar Aircraft Co., in the December issue of MODERN CASTINGS. For an idea of what he thinks of your casting method see "A Hard Look at the Castings Industry" next month.

PLEAS FOR RELEASE of Chilean copper from stockpile to relieve the tight metal situation among brass and bronze foundries have not been successful according to the Non-Ferrous Founders' Society's Crucible. Contention now is that even the President cannot release material except for the defense of the United States. In the case of aluminum, Washington is moving very slowly on remedial measures. During the 4th quarter some release from stockpile is expected. By the middle of 1956, production will be about equal to present anticipated use. More scrap needs to be removed from export to make the foundryman's position more secure

YOU CAN SEE tomorrow's foundry technology, according to early indications of castings industry equipment and supply people, by taking in the 1956 AFS Castings Congress. One exhibitor says he'll show how to make cold-bond shells in a machine usually used for green sand molding. Shells are produced in shallow tight flasks using a diaphragm molding machine and sodium silicate bonded sand. A shot of CO_2 through the pattern or through probes attached to the pattern give a shell that can be locked up for pouring about five seconds later.

MAGNESIUM CASTING shipments through August continue slightly ahead of the 1954 year-to-date totals according to a Magnesium Association analysis of U. S. Department of Commerce figures. Total August shipments were 1088 tons, up 13 per cent from the July total of 960 tons and about 1 per cent above last year's figure of 1078 tons. Magnesium sand castings with an increase of 21 per cent and die castings with an increase of 46 per cent were well over July magnesium shipments. Permanent mold castings dropped 21 per cent. Comparative totals were: sand castings, August 596, July 491; die castings, August 267, July 183; permanent mold castings, August 225, July 286.

Herbert P. Scobie

Lindberg-Fisher manufactures all types of Aluminum Melting and Holding Furnaces for permanent mold application— Gas-Oil- Electric resistance.

Lindberg-Fisher engineers can intelligently recommend the type of furnace to best suit your needs and conditions.

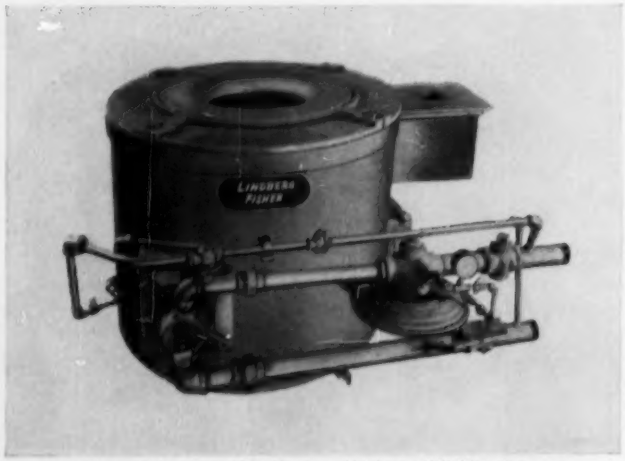
Melting specialists for 25 years
Sales and service offices in principal cities

LINDBERG FISHER

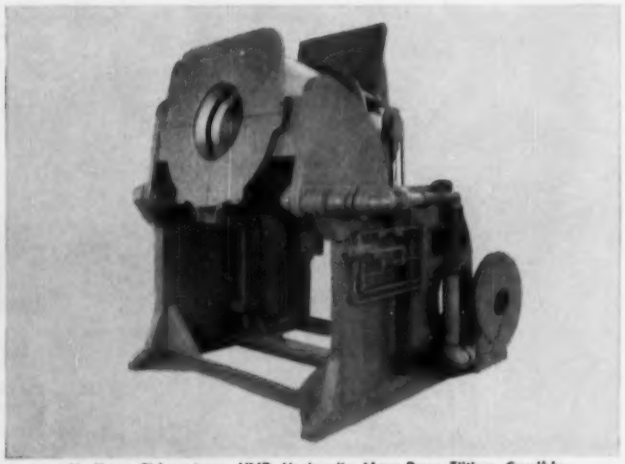
MELTING FURNACES

A Division of Lindberg Engineering Company,
2440 West Hubbard Street, Chicago 12, Illinois

Lindberg-Fisher Electric Resistance Aluminum Melting and Holding Furnace equipped with heavy duty resistance elements which give uniform distribution of heat, insuring long element and pot life. Capacities up to 1000 lbs. Described in Bulletin 320.



Lindberg-Fisher type ADC Aluminum Melting and Holding Furnace. Capacities up to 1000 lbs. of aluminum. Oil or gas fired. Described in Bulletin 301.



Lindberg-Fisher type HNP Hydraulic Nose-Pour Tilting Crucible Furnace. Pouring lip is located in the axis of tilting providing a constant pouring arc regardless of degree of furnace tilt. Capacities up to 1000 lbs. of aluminum. Oil or gas fired. Described in Bulletin 57-A.

CIRCLE No. 92, PAGE 79-80

program we have greatly *reduced* the hazards of material handling in which chains are used. We feel, however, that the title *"No Chain Failures in This Foundry"* will be interpreted by some as being too idealistic and boastful, thereby detracting from the authenticity of the article if not the integrity of the writer. In addition, we wouldn't want to create a false sense of security in plants where our program might be installed.

JESS HOGANS, *Safety Dir.*
Fairbanks, Morse & Co.
Beloit, Wis.

MODERN CASTINGS hopes its enthusiasm for the chain safety program at Fairbanks, Morse & Co. which resulted in the story title will not blind readers to the importance of constantly teaching safe practices and emphasizing the role of the individual in safety. A large proportion of industrial as well as home and highway accidents are due to human—not mechanical—failure. There is no substitute for use of gray matter in accident prevention.—Editor.

We are greatly impressed by the article *"No Chain Failures in This Foundry."* Congratulations on an excellent story. Please send 25 complete issues for August.

N. ALLAN PETTIT, *Adv. Mgr.*
Campbell Chain Co.
York, Pa.

how much can we produce?

■ We are interested in obtaining figures relating to production capacity in the foundry industry as well as data on industrial capacity in general.

R. M. FORQUER, *Asst. Compt.*
American Brake Shoe Co.
New York

This is a rather difficult question to answer absolutely since so much depends on ability to run extra shifts, but we can give certain indications as to capacity. Record year for the castings industry was 1951 although 1953 was the record year for industrial production as a whole. Shipments of castings in 1951 were (in short tons):

Gray Iron	14,980,000
Steel	2,050,000
Malleable Iron	1,080,000
Non-Ferrous	1,130,000

The Gray Iron Founders' Society

recently suggested that 1955 shipments, with gray iron shops operating at 93.8 per cent of capacity in March, may exceed 1953, second best year when over 13.7 million tons of gray iron were shipped.

Determining factor in capacity may well be manpower. Foundries have been operating at record or near-record levels this year. According to the Bureau of Labor Statistics the average worker in May 1954 was working 42.8 hours, compared with 38.3 hours in May 1955 in iron and steel foundries. In non-ferrous foundries the figures are respectively 41.1 and 39.5 hours.

For more specific information it may be that the Joint Committee on the Economic Report of the 83rd Congress will give you projections to 1965—at least this report will give you the general data on industrial capacity that you seek. The National Production Authority of the U. S. Department of Commerce has made studies of production capacity of specific industries and it may be that they have covered the foundry industry. The forthcoming Census of Manufactures will contain valuable information. This is supposed to be available in the last quarter of 1955.

The fact that many foundries have closed in the past two years, although an almost equal number have reopened, would indicate that foundries are operating considerably short of capacity even when they are reaching record production levels. A further indication is the highly competitive nature of the business pricewise.

For additional information on the general industrial picture consult the studies of the Machinery & Allied Products Institute, the Survey of Current Business of the U. S. Department of Commerce, and the reports of the Federal Reserve Board.—Editor.

need more metal mold facts

■ The American Foundrymen's Society has been particularly weak in the technical field of permanent mold and die casting of light metals, yet we are manufacturing four times as much die casting and permanent mold alloys as we are sand casting alloys.

The die castings shop is as much

INDUSTRY-WIDE COVERAGE..

there are more "SW" Cupola Collectors in operation today than those of all other manufacturers

The numerals in the circles on the map indicate the number of Schneible "SW" Cupola Collectors (as pictured above) in operation in each of the cities shown. A total of 57 such collectors are in use at both large and small foundries in these communities. These "SW" Collectors meet Air Pollution Code requirements in every city where such codes are in force.

Schneible is America's largest producer of wet method Cupola Collectors for the foundry industry.

For twenty years foundrymen and Schneible engineers have worked hand-in-hand to devise better, more efficient methods of controlling air pollution in the industry.

One of the outgrowths of this close cooperation is the "SW" Cupola Collector which has proven to be by far, the simplest, most economical and efficient collector ever designed for control of Cupola fly-ash and fumes.

Foundrymen in every important industrial center of the country look to Schneible for dust and fume control equipment that gives outstanding performance year after year with minimum maintenance.

FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION INC. MEMBER FEMA

All Schneible Equipment is covered by patents in United States and foreign countries.

CLAUDE B. SCHNEIBLE COMPANY
P. O. Box 81, North End Station • Detroit 2, Michigan
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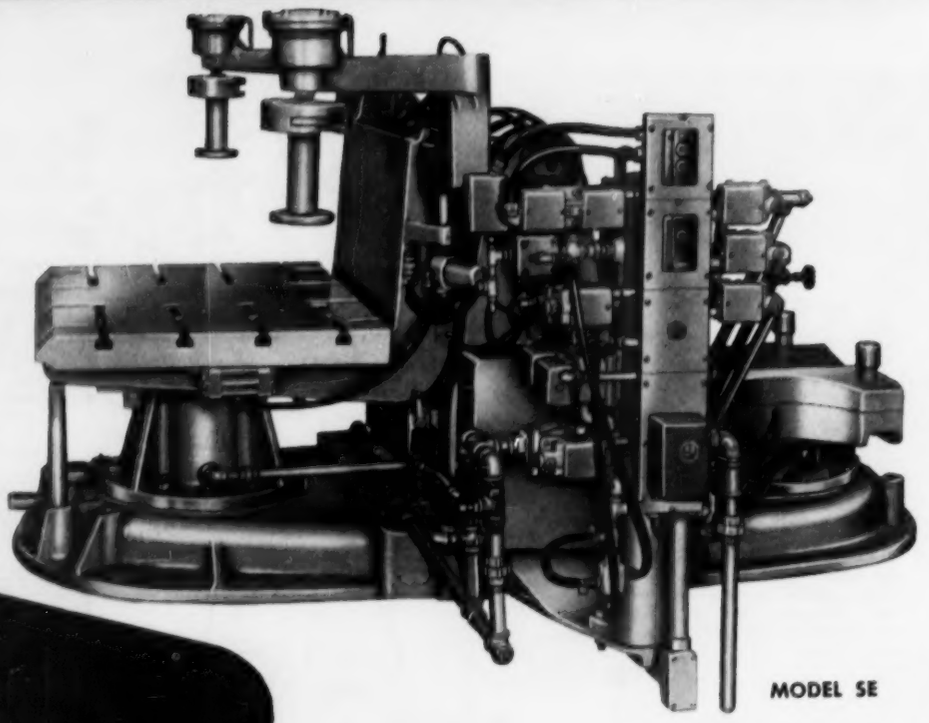
European Licensee: Elex S. A., Zurich, Switzerland

SCHNEIBLE

AUTOMATIC ROLLOVER



MODEL SE

shortens molding cycle— eliminates adjustments to change patterns

When a mold has been rammed and is ready to be rolled over, the operator will press a button to complete the mold.

While the machine is rolling over, drawing the mold and rolling back, the operator will get ready for the next mold so the flask can be placed as soon as the pattern is rolled back.

Only seconds are required to replace a pair of clamp spools with a pair of the right height when changing patterns.

Jolting will be started by pressing a button and stopped automatically after a predetermined number of jolts have been made. The time cycle can be adjusted quickly to change the number of jolts.

Automatic rollovers are available in sizes from 1,000 to 12,000 pounds capacity.

Automatic controls can be added to late model rollovers now in operation. Write for details giving model and serial numbers.

davenport MACHINE and FOUNDRY COMPANY
DAVENPORT, IOWA

a foundry as the sand shop.

If there is any way that the Die Casting Committee and the Permanent Mold Committee of the AFS Light Metals Div. could be reactivated, I would like to see progress in this direction.

LEONARD GREENFIELD, Plant Mgr.
Samuel Greenfield Co., Inc.
Buffalo, N.Y.

Between 1952 and 1954 the proportion of aluminum castings produced in sand dropped from 38 to 25 per cent, while die castings rose from 32 to 38 per cent and permanent mold castings from 28 to 35 per cent. AFS is editing a book on die casting. While articles on die casting and permanent mold casting have appeared in MODERN CASTINGS and TRANSACTIONS from time to time, failure to publish more has been due to the reluctance of authorities to divulge information or prepare material for publication.—Editor.

---

11 Rules Simplify Drafting

Drafting time can be cut 40 to 50 per cent by following the rules below according to J. H. Bergen, standards administrator of the engineering division, American Machine & Foundry Co., New York.

1. Use description to eliminate delineation.
2. Use description to eliminate projected views.
3. Omit elaborate, pictorial, or repetitive detail.
4. Use keyed legend to indicate nuts, bolts, and other hardware. Show outline only where necessary to indicate position.
5. Only use dotted lines to add clarification.
6. Only use cross-sectioning to add clarification.
7. Use symbols to indicate various hole sizes.
8. Avoid the use of hand lettering.
9. Avoid the use of arrow heads.
10. Use datum lines.
11. Make free-hand drawings where possible. Use cross-sectioned board cover.

CIRCLE NO. 94, PAGE 79-80

let's get personal

Howard F. Taylor has been named American Brake Shoe Company Professor of Foundry Metallurgy at Massachusetts Institute of Technology. The company established this chair in the engineering school specifically for Taylor who is now professor of metallurgy and director of the M.I.T. foundry laboratory. In announcing the new chair, Dr. C. Richard Soderberg stated that it recognizes "... the life work of Professor Taylor, who more than anyone else, has infused into the field, the spirit of scientific methods and research." Previous awards honoring Taylor's contribution to foundry research include the first Peter L. Simpson Gold Medal awarded by the American Foundrymen's Society and the Army-Navy Distinguished Civilian Service Award. Professor Taylor is co-author of a basic textbook, *Metallurgy for Engineers*, and of another, *Foundry Engineering*, to be published early next year.

Dr. Clarence E. Larson has been appointed vice-president in charge of research for National Carbon Co., Cleveland.

B. D. Claffey has been appointed general manager of the G.H.R. Division of Dayton Malleable Iron Co., Dayton, Ohio. He has been serving as general manager of the company's Ohio Malleable Division.

David C. Ekey has left Pennsylvania State University after 4 years as assistant professor of industrial engineering to become director of Lebanon Steel Foundry's expanded foundry research department, Lebanon, Pa.

Donald L. Crews has been named director of applied research and development for James B. Clow & Sons, Inc., Chicago. Before taking this position, he was associate professor of metallurgical engineering at the University of Cincinnati.

Russell T. Lund has been made a vice president of National Carbide Co., Calvert City, Ky.

H. C. Esgar, for the past four years a staff member of Foundry Educational Foundation, has been named

B. D. Claffey

D. L. Crews

H. F. Taylor

MARKAL

Paintstiks

For Marking HOT SURFACES—up to 2000° F.
Steel ingots, welding, heat treated metal.

COLD SURFACES—as low as—50° F.
Any surface, wet or dry, icy, rough or slick.

A complete line of PAINTSTIKS offers the selection of the correct marker for any given job.

The wide variety of Markal Paintstiks makes it possible to correctly mark your products knowing that the mark will be permanent or can be removed when you want it. Temperatures, hot or cold, are no problem as there is a Paintstik for all conditions. Hot castings for example can be marked and immediately immersed in cold water bath without defacing the markings. Paintstiks provide a mark that remains highly legible, adheres to the surface and will not run, char, flow, discolor, peel or crack. Specify Markal Paintstik the next time you order.

FREE SAMPLE UPON REQUEST

Here are a few of the many uses

- ✓ Marking hot castings
- ✓ Marking billets (cold)
- ✓ Marking cold plates for identification
- ✓ Marking parts to withstand range of annealing temperatures
- ✓ Marking steel ingots at 1600°F
- ✓ Marking hot metal slabs
- ✓ Marking guide lines for torch cutting and welding
- ✓ Marking metal parts
- ✓ Marking in color for identification and coding

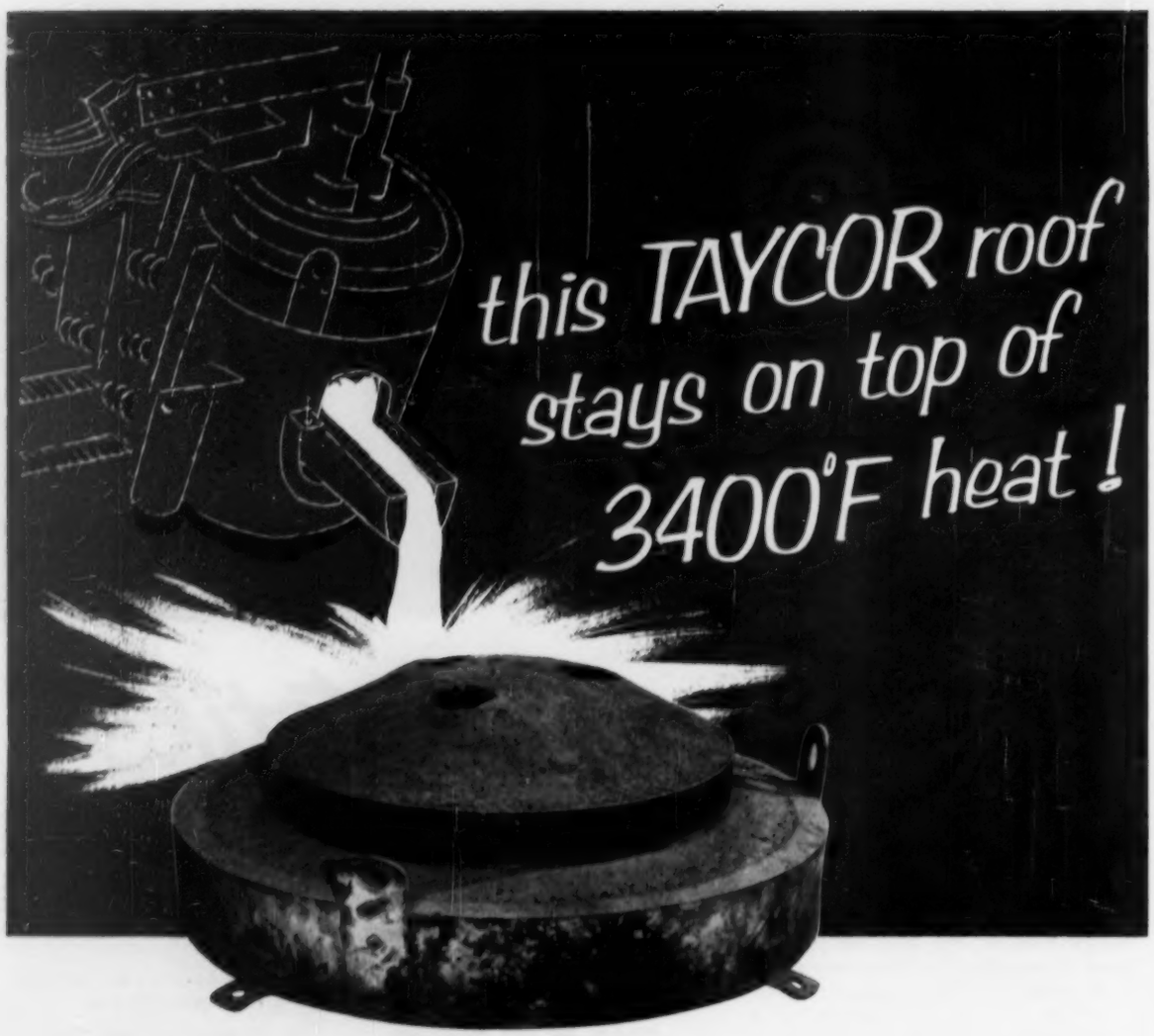
For special problems, write for engineering aid.

Markal COMPANY

THE MARK OF QUALITY
• • • •
MARKAL PAINTSTIKS

2093 WEST CARROLL AVENUE, CHICAGO 12, ILLINOIS

CIRCLE NO. 99, PAGE 79-80



This monolithic roof of TAYCOR Ramming Mix is for a 1000-lb. basic direct arc furnace used to melt a variety of heat-resistant alloys. Furnace operates 16 hours daily at temperatures as high as 3400° F. Extensive tests have been conducted to improve roof life for this severe application. The result of these tests proved TAYCOR Ramming Mix lasted *two to three times longer* than any other refractory. TAYCOR roof life varies from a low of 200 heats to a 900-heat record high, depending upon the alloy being melted.

TAYCOR is our trade name for Corundum-base super-refractory brick, special shapes, cements, patches and ramming mixes. The outstanding properties of TAYCOR are exceptional refractoriness, high hot load strength, superior resistance to mechanical abrasion and attack from iron oxide.

These properties make TAYCOR the ideal refractory for hearths, piers, slot bottoms, front walls, skid rails of forge, heating and heat-treating furnaces . . . for small basic direct arc furnaces operated at higher-than-normal temperatures, requiring long heats . . . for linings of indirect arc furnaces . . . for rammed crucibles of high-frequency induction furnaces. Put TAYCOR to the test in your furnaces. For further information, write direct or call in a Taylor field engineer.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

The CHAS. TAYLOR SONS Co.
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U.S.A.

CIRCLE NO. 100, PAGE 79-80

district manager of *Materials and Methods* for eastern Ohio and western Pennsylvania.

E. Harold Mitchell, Detroit, has been appointed field director of the Gray Iron Founders' Society.

E. H. Mitchell

Prior to his appointment he was sales engineer for the Weatherhead Co., Cleveland.

Leon H. Decker has been promoted to assistant works manager of the foundries and pattern shops, industries group, Allis-Chalmers Manufacturing Co., Milwaukee. Decker had been general superintendent of foundries and pattern

L. H. Decker

shops at the firm's West Allis works. He is a past director of the Wisconsin Chapter of the American Foundrymen's Society.

John O. White has been named sales engineer, foundry department, Baldwin-Lima-Hamilton Corp., Philadelphia.

A. L. Fruchtl has resigned after six years as resident manager of U. S. Pipe & Foundry's Birmingham,

Ala., plant to join W. Thomas Barr Associates, Birmingham.

Richard C. Campbell has joined Metal & Thermit Corp., New York, as metallurgical sales engineer.

Thaddeus Giszczak and **Paul B. Guilford** have been promoted to new positions at General Motors'

T. Giszczak

Central Foundry Division, Defiance, Ohio. Giszczak leaves the position chief metallurgist to become factory manager while Guilford advances to the post of chief metallurgist.

P. B. Guilford

Shell Process, Inc., Chicopee, Mass., has announced the appointment of the following sales representatives: **Thomas Barr, Fred W. Fuller, Herbert H. Klein, Robert F. Guion, Joseph G. Risney, Edwin A. Swensson, E. C. Troy, H. Howard Updegraff,** and **Otto Rosentreter.**

W. H. Boom has been appointed chairman of the board, G. Dikkers

CIRCLE NO. 101, PAGE 79-80

Monsanto Profit Pictures

Shell molds bonded with Resinox 736 produce smooth-surface castings which need no grinding to eliminate fins.

Link-Belt Company reports: Sharper detail, smoother finish with **Resinox 736**

MONSANTO'S PHENOLIC RESIN HELPS DELIVER MORE GOOD CASTINGS PER TON OF METAL POURED

The superior performance of Resinox 736 has been demonstrated again in one of the nation's leading foundries.

In a three-year test at Link-Belt Company's Ewart plant in Indianapolis, Resinox 736 proved to have the right combination of properties to shell mold precision parts at fast production rates.

Molds bonded with various resins were compared for speed of investment, speed of cure, dimensional stability, tensile strength and resistance to heat shock. The experiments proved Resinox 736 did the job better than any other resin now available. Link-Belt reports getting castings with sharper detail and smoother finish. Machining costs are greatly reduced—often eliminated altogether.

With the economy and quality of shell molding depending so much on the resin used, it will pay *you* to specify Resinox 736.

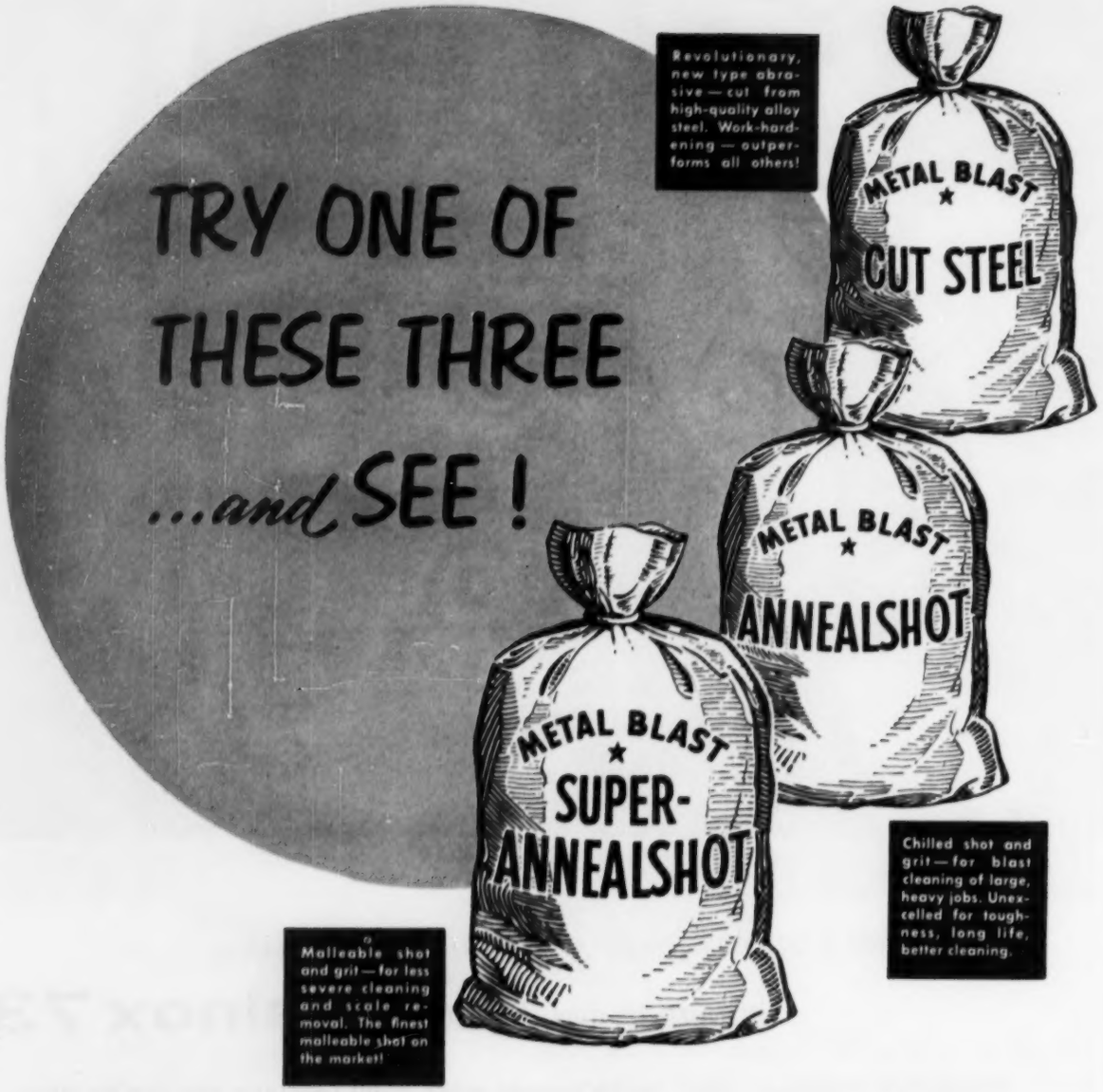
For a complete line of shell molding, core binding and sand conditioning resins that are research-developed and shop-tested to meet your needs, write to Monsanto Chemical Company, Plastics Division, Dept AF11, Springfield 2, Mass.

Sprockets cast by Link-Belt Co. in Resinox-bonded shell molds require no machining before threading.

MONSANTO

For Stronger shell molds, specify

RESINOX®


TRY ONE OF THESE THREE ...and SEE !
Revolutionary, new type abrasive — cut from high-quality alloy steel. Work-hardening — outperforms all others!
METAL BLAST ★ CUT STEEL
METAL BLAST ★ ANNEALSHOT
METAL BLAST ★ SUPER-ANNEALSHOT
Chilled shot and grit — for blast cleaning of large, heavy jobs. Unexcelled for toughness, long life, better cleaning.
Malleable shot and grit — for less severe cleaning and scale removal. The finest malleable shot on the market!

No matter which of METAL BLAST'S three abrasives you choose for your blast-cleaning requirements —you'll get unexcelled efficiency and economy. For these are *good* abrasives—made of top quality materials, on modern equipment, with the greatest of care. If you aren't fully satisfied with the abrasive you're now using, why not try one of these three? Send in your trial order today!

METAL BLAST, INC.

872 EAST 67th STREET • CLEVELAND 3, OHIO

THERE'S A **METAL BLAST** ABRASIVE FOR EVERY CLEANING REQUIREMENT

& Co. N. V., Hengelo (O), The Netherlands. **W. B. K. Boom** and **W. Muller** have been named as directors.

J. Dean Herman, chief chemical engineer, **Gerald A. Munson,** chief mineral engineer, and **John Talley, Sr.,** branch manager, are the latest organizational changes announced by Lithium Corporation of America, Inc., Minneapolis.

L. F. Williams

Lawrence F. Williams has been elected president of Cooper-Bessemer Corp., Mt. Vernon, Ohio. **James E. Brown,** treasurer of the company, was elected to serve also as secretary, replacing Williams.

Jas. E. Brown

Dr. Jacob O. Kamm has been elected president of the Cleveland Quarries Co, Amherst, Ohio, and its subsidiary, Silica Chemicals, Inc. He was previously executive vice-president of the firms.

William M. Oliver has been appointed process development engineer at Acheson Colloids Port Huron, Mich., plant. He replaces **Bart Dickey** who has been promoted to production manager.

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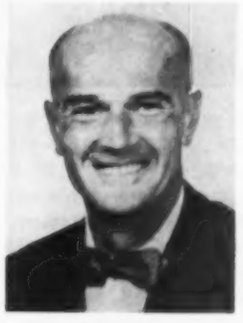
W. C. Truckenmiller has been appointed assisant technical director of Albion Malleable Iron Co., Albion Mich. Also announced is the

W. C. Truckenmiller

assignment of **E. F. Chojnowski** as research metallurgist.

William R. Robinson has been made district salesman for Syntron Reading Sales Co. and **E. W. Rasmussen** has been made district salesman for Syntron San Francisco Sales Co.

Samuel T. Page has been named director of the chemical department of Sam Tour & Co., Inc., New York. **Dr. Gregory Pantchenko** has been appointed assistant director.



E. L. Penn

Edward L. Penn has been appointed field service engineer by Shallway Corp., Connellsville, Pa.

P. J. McDonough has been appointed safety director of Semet-Solvay Div., Allied Chemical & Dye Corp., New York.

Don't Gamble

with Iron QUALITY

Use Famous CORNELL CUPOLA FLUX

Gray iron and malleable iron foundries with cupolas pride themselves on quality metal—know a fluidizer is a must! That's why so many insist on Famous Cornell, the metal-purifying flux that eliminates foreign matter from molten iron by increasing slag flow off.

Once you have used Famous Cornell Flux you'll be pleased at the improved tensile strength of your castings and how easy they are to machine. Famous Cornell Flux also reduces patching downtime by imparting a protective glazed surface on cupola linings.

Write for Bulletin 46-B and a sales engineer to show you how Famous Cornell Flux can help you.

No Gamble when you use Famous CORNELL Aluminum and Brass Flux

- Makes metal pure and clean.
- Permits use of more scrap without danger of dirt, porous places or spongy spots, due to dirty metal.
- Thinner, yet stronger sections can be poured.
- Metal does not cling to the dross as readily.
- Crucible or furnace linings are kept clean and preserved.
- Cleanses molten brass even when the dirtiest brass turnings or sweepings are used.
- Saves considerable tin and other metals.
- Forms a perfect covering over the metal during melting, prevents oxidation and reduces obnoxious gases to a great extent.

Write for Bulletin 46-A

The **CLEVELAND FLUX** *Company*

1026-40 MAIN AVENUE, N. W. • CLEVELAND 13, OHIO

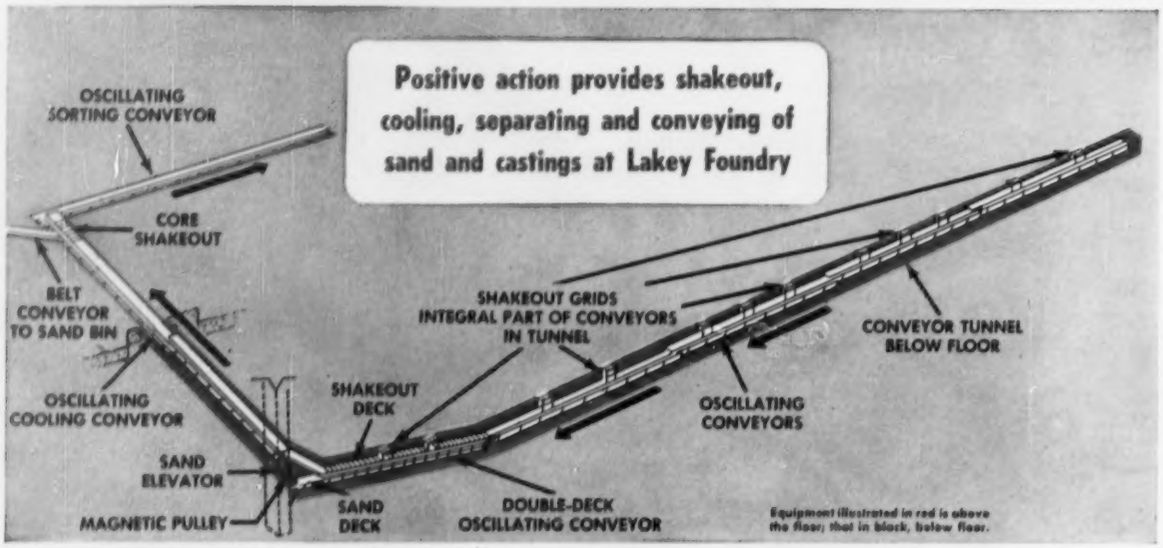
Manufacturers of Iron, Semi-Steel, Malleable, Brass, Bronze, Aluminum and Ladle Fluxes—Since 1918

FAMOUS CORNELL FLUXES

Trade Mark Registered

CIRCLE NO. 105, PAGE 79-80

Gets MULTIPLE-DUTY with LINK-BELT Oscillating Conveyors


Positive action provides shakeout, cooling, separating and conveying of sand and castings at Lakey Foundry
OSCILLATING SORTING CONVEYOR
CORE SHAKEOUT
BELT CONVEYOR TO SAND BIN
SHAKEOUT GRIDS INTEGRAL PART OF CONVEYORS IN TUNNEL
CONVEYOR TUNNEL BELOW FLOOR
OSCILLATING COOLING CONVEYOR
SHAKEOUT DECK
OSCILLATING CONVEYORS
SAND ELEVATOR
MAGNETIC PULLEY
SAND DECK
DOUBLE-DECK OSCILLATING CONVEYOR
Equipment illustrated in red is above the floor; that in black, below floor.

HERE'S proof that the positive action of Link-Belt Oscillating Conveyors is not affected by surges. The installation at Lakey Foundry, Muskegon, Mich., has 430 ft. of oscillating conveyors performing multiple duties in handling 185 tph of sand and castings.

Five 48-in. wide oscillating conveyors in this system are located under the floor. All have shakeout grids integral with the trough and extending above the floor. Grid units function as tight-flask shakeouts, and sand and castings drop to conveyor trough. The fifth conveyor is double-decked. Sand conveyed on the lower deck passes under a magnetic pulley to remove metal, then is discharged into a bucket elevator. Castings on the upper deck are discharged to inclined oscillating conveyors for cooling and delivery to core shakeout. A flat-top oscillating conveyor above the floor is used for picking and sorting.

Link-Belt equipment and engineering experience — which have produced installations handling up to 450 tph — can bring similar high productivity to your own foundry. For facts on Link-Belt Oscillating Conveyors, call your nearby Link-Belt office or write for Book 2444. These conveyors in standard 36-in. wide sections are available from local stocks.

At shakeout stations, oscillating motion of conveyors breaks sand from flask when flask is set on grids extending up through floor. Sand and castings fall into oscillators.

Link-Belt double-deck oscillator is fed by four other conveyors in tunnel. Top deck carries castings; lower conveys sand under magnetic pulley to bucket elevator.

Worker sorts castings from 54-in. flat-top sorting oscillating conveyor, after the Link-Belt shakeout has knocked out the cores. Capacity is 35 tph.

LINK-BELT

CONVEYORS AND PREPARATION MACHINERY

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.081

CIRCLE NO. 104, PAGE 79-80

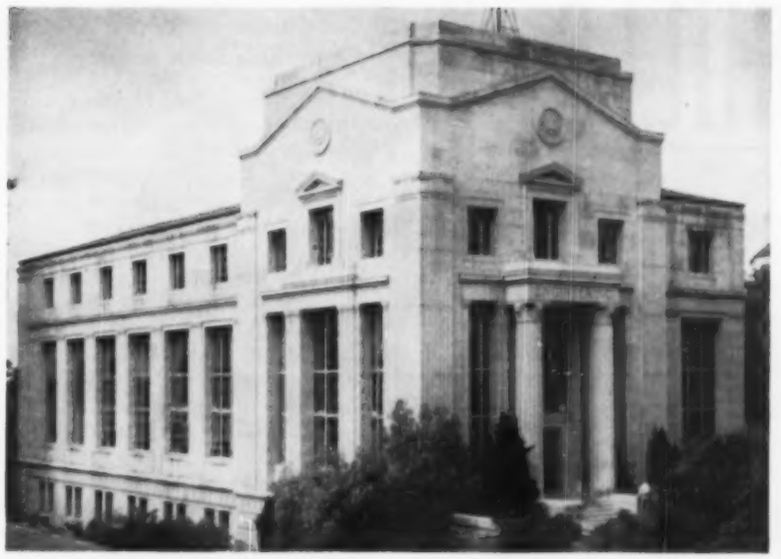
H. Bornstein, retired director of laboratories, Deere & Co., Moline, Ill., and a past president of the American Foundrymen's Society, has been named temporary secretary of the AFS Alumni Group to fill the gap left by the death of R. E. Kennedy, AFS secretary emeritus,. and secretary of the Alumni Group.

Western spirit prevails as Roy W. Schroeder, associate professor, University of Illinois, visits Electric Steel Foundry Co., Portland, Ore. Shaking hands with Professor Schroeder is Harold Gowing of Electric Steel. At right is Harry Czyzewski, Metallurgical Engineers, Inc., chairman of the AFS Oregon Chapter.

Pointers are offered James L. Leach, associate professor of mechanical engineering, University of Illinois, during the college professor summer employment program at Caterpillar Tractor Co., Peoria, Ill. He is discussing a cupola operations report with F. K. Butterfield, general foreman, foundry conversion.

Looking . . .

. . . for new production ideas? Circle numbers on Reader Service cards (page 79-80) to get more information on products and services described in Products & Processes and For the Asking.



University of California (Berkeley) engineering building where first educational work on West Coast under FEF sponsorship will be conducted.

Foundation Now Active Coast to Coast

■ With the inauguration this fall of Foundry Educational Foundation programs at the University of Kentucky (Lexington) University of Illinois (Urbana and Chicago), and University of California (Berkeley), FEF has spread its influence from coast to coast and has brought the number of participating schools up to 16.

The program at California will be under the direction of Prof. E. Paul DeGarmo, assistant dean, Collete of Engineering, and Prof. James S. Campbell, associate professor, Mechanical Engineering.

At Kentucky, Prof. C. S. Crouse, head of Mining & Metallurgical Engineering will be in charge, assisted by Dr. Roy E. Swift, associate professor in the same department.

Prof. N. A. Parker, head of Mechanical Engineering will supervise the Illinois program at the downstate Urbana campus with Prof. J. L. Leach, associate professor in the same department teaching foundry courses. At the Chicago Undergraduate Division, Prof. R. W. Schroeder, associate professor of Foundry and Pattern Design will conduct the program under the direction of Associate Dean Fred W. Trezise.

Assisting the schools in developing their cast metals programs will be Industrial Advisory Committees of representatives of leading foundries in the area of each school.

Organized in 1947, the FEF program fosters education in the field of foundry science, engineering, and practice in colleges and universities and encourages and assists students in acquiring this education. Approximately 200 scholarships are granted annually.

FEF schools, in addition to the three new affiliates, are: Universities of Alabama, Cincinnati, Cornell, Michigan, Michigan State, Ohio State, Pennsylvania State, Purdue, and Wisconsin, together with Case, Illinois, and Massachusetts Institutes of Technology, and Missouri School of Mines.

Accident Data Published

"Accident Facts", a statistical yearbook published by the National Safety Council, is now available.

Twenty pages are devoted exclusively to occupational accidents.

"Accident Facts" is priced at 75 cents a copy (less for quantities) and can be obtained by writing the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

Easy to keep **PERMANENT RECORDS**

OF SAND MOISTURE

With the

DIETERT-DETROIT

MOIST RECORDER

1. No other single factor causes more variation in molding conditions and casting quality than fluctuations in the moisture content of molding sands.
2. The MOIST RECORDER tests and records the moisture content of sand in bin, hopper or on a moving conveyor. It doesn't miss a batch.
3. A continuous record gives your foundry an exact basis for correlating moisture variations with casting results.
4. Signal lights automatically indicate if sand is running above or below the desired moisture content. Audible alarms may be employed if desired.
5. The DIETERT-DETROIT MOIST RECORDER utilizes the proven, reliable high frequency capacitance method of moisture measurement. The unit is self-contained, compact, easily installed.

So confident are we that you will be completely satisfied with the benefits obtained, that we offer the MOIST RECORDER on a 30-day trial basis, without obligation.

HARRY W. DIETERT CO. *Control* EQUIPMENT

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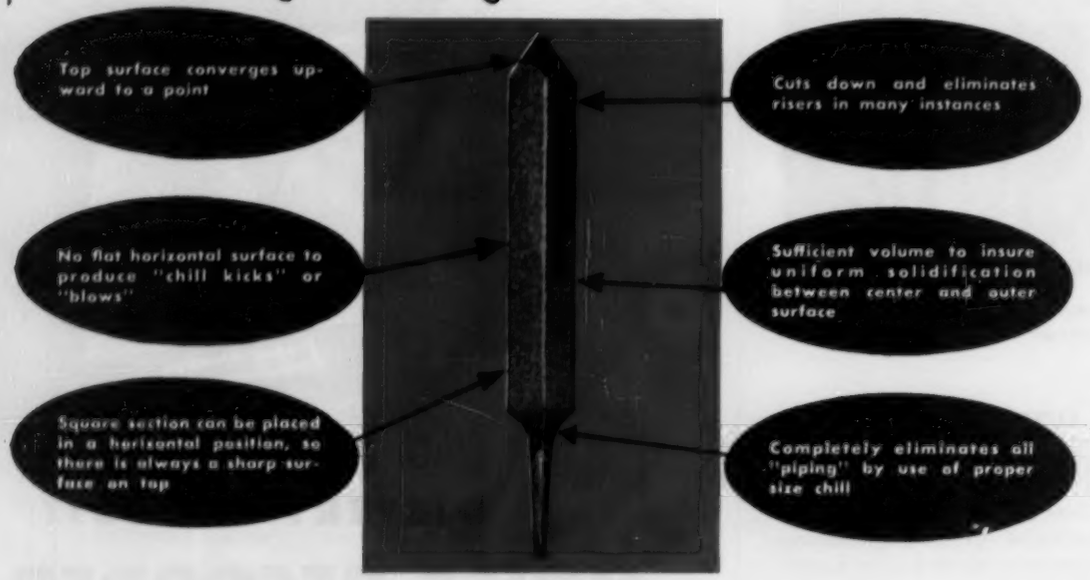
9330 Roselawn, Detroit 4, Michigan
Rush me details on the Moist Recorder and your 30-day trial offer.
Name
Company
Address
City State

CIRCLE NO. 124, PAGE 79-80

fine FANNER SUPERCHILLS

provide casting advantages available in no other chills


Top surface converges upward to a point
No flat horizontal surface to produce "chill kicks" or "blows"
Square section can be placed in a horizontal position, so there is always a sharp surface on top
Cuts down and eliminates risers in many instances
Sufficient volume to insure uniform solidification between center and outer surface
Completely eliminates all "piping" by use of proper size chill

scientifically designed to produce proper chilling at lowest cost

Fanner Superchills are superior in the pouring operation because they are scientifically designed to produce proper chilling without "blows" . . . without "kicking away" . . . without defects. The top surface has a tapered point which is enveloped gradually as molten metal rises in the pouring operation . . . allowing ample time for gases to escape before

Superchill is submerged and fused. (See cross section). The *center section* is square so that the Superchill can be placed in a horizontal position in such a way that there is no flat surface at the top but a corner at all times. Square headed tacks in the core box or on the pattern are used to indicate position. Frequently, when a round chill is used, fusion is not complete, and when drilled, the chill turns with consequent breakage. The square Superchill cannot turn . . . and its corners aid in fusion. If you do not have complete information on these exceptional Superchills, write for details today.

Qualified and specialized engineers in Fanner's Technical Service Division are available for consultation, without obligation, on problems of producing more intricate castings; developing increased strength, closer tolerances, and better quality; reducing machining and improving finish—both in ferrous and non-ferrous castings. Take advantage of the research and development work that Fanner has invested in this field to improve your profit picture. Simply direct your request to the address shown below.

Fine Fanner Superchills are made in a wide variety of sizes and shapes — uncoated or coppered. They provide better surfaces for molten metal to join with and more chilling volume per pound. They have universal use throughout industry.

THE FANNER MANUFACTURING CO.

Designers and Manufacturers of Fine Fanner Chaplets and Chills

BROOKSIDE PARK CLEVELAND 9, OHIO

CIRCLE NO. 103, PAGE 79-80

Good Business Forecast By Machine Show Activity

The biggest single impression that the September National Machine Tool Show in Chicago gave to MODERN CASTINGS inquirers is that business is terrific and getting even better.

At the beginning of 1955 prospects were good and machine tool builders were optimistic—but they still did not look for record activity. Indications at the Machine Tool Show were that the exhibitors' total business may not even be as high in 1955 as it was in 1954 but this is because of the year's slow start. As of October 1, machine tool builders were tremendously busy, current sales were substantially ahead of the same period of 1954, and most companies were quoting four to six months delivery time.

Several machine tool builders said their backlog of unfilled orders was double that of a year ago. For the industry as a whole, the order backlog was 5.4 months in mid-August compared with 3.2 months the year before.

If any trend was to be noted in the type of equipment sold it is a trend toward automated equipment and also for equipment with automatic loading and unloading devices or attachments. The big aim of buyers is to save man power—not only because of its rising cost but also its increasing shortage.

With machine tool buying currently proceeding at a faster rate than any person or survey had forecast, the major impetus is the expectation of even better business in 1956. Manufacturers and foundrymen who felt that business activity had reached a plateau or was declining, had reduced their orders to absolute requirements. But expectations of even better business in 1956 has caused a complete revision in thinking about machinery needs.

Industrial sales as a whole are running 18 per cent higher than in the same period of 1954.

Prices of machine tools and equipment are about 5 per cent to 10 per cent higher than a year ago, without including the addition of increased electronic operating controls and materials handling devices.

NATIONAL BENTONITE helped manufacture this Caterpillar® giant!

This Caterpillar® DW21 Tractor and Scraper—shown stripping blow sand overburden from a deposit of bentonite—had many of their important parts cast in molds bonded with this same mineral. Castings for such heavy equipment must obviously be cast sound without any defects. That's why scores of good foundrymen the nation over specify National Bentonite to bond their molds. It's mined from the purest deposits of bentonite in the world . . . provides greater mold permeability, higher tensile strength, good green strength, higher hot strength, higher sintering point, and many other advantages.

Whatever the metal you're pouring — malleable iron, gray iron, steel, brass, aluminum, or magnesium — National Bentonite used as a bonding agent in your sand will produce finer, smoother castings and cut your reject loss. There are scores of good reasons why you should specify National Bentonite. Write today for folder and technical specifications.

BAROID

Baroid Division ☆ National Lead Company

Bentonite Sales Office: Railway Exchange Building, Chicago 4, Illinois

Baroid

CIRCLE NO. 122, PAGE 79-80

Linbond
CORE OIL
No. 742

The Iron Lion Head reproduced in our ad is shown through the courtesy of the Detroit Institute of Arts. It dates from the T'ang Dynasty, A.D. 618-907. We will be glad to furnish a detailed description of this grand old work of art if you write us.

NO self-respecting lion would want his mane marcelled in this fashion, but the artist liked it, so Leo got the new look. Your core room can have a new look too if a strong oil like Linbond is used. Bet on the best and watch that pile of scrap cores disappear. Linbond does it every day. It has all the strength that can be built into a core binder and it offers peak protection for an uncontrolled oven. *Write us for Bulletin No. 6 and see how Linbond compares with Linseed in tests by Dietert.*

The newest member of our Linbond family is a fast baking oil—Linbond FB 72. Are you crowded for more oven capacity? Do you need to get the cores through faster? Well, this is one answer and a sure one, too. You can measure a real saving in baking with Linbond FB 72. *Write us for a chart showing (a) its speed for gaining top strength and (b) the long level time-line over which this strength is sustained. Linbond FB is our new brand for this brand new oil.*

UNITED OIL MFG. COMPANY
1429 WALNUT STREET, ERIE, PA.

CIRCLE NO. 123, PAGE 79-80

Show Casting Processes At General Motors Powerama

■ More than two million visitors passed through the gates of the General Motors Powerama at Chicago before it closed on September 25. And a goodly share of these saw metal cast for the first time and witnessed other foundry demonstrations in GM's Fabricast exhibit.

All visitors to the Fabricast Division part of the show were given a gold styron plastic key chain medallion which was made as one of the working demonstrations of the exhibit. The medallion was cast to illustrate the first step in making expendable patterns for the "lost wax process". This investment process was demonstrated further in an exhibit of heat-resistant heavy alloy blades and vanes for jet aircraft engines.

Part of the demonstration included a transcriber machine and comparator table operated by skilled layout men to demonstrate how the dimensions of the cast turbine blades are checked. A fluorescent penetrant display also illustrated one of Fabricast's testing procedures.

The foundry exhibit included a permanent mold machine which produced aluminum crankcase inspection covers for Diesel locomotives. The castings were shipped directly from the Powerama to GM's Electro-Motive Division at LaGrange, Ill.

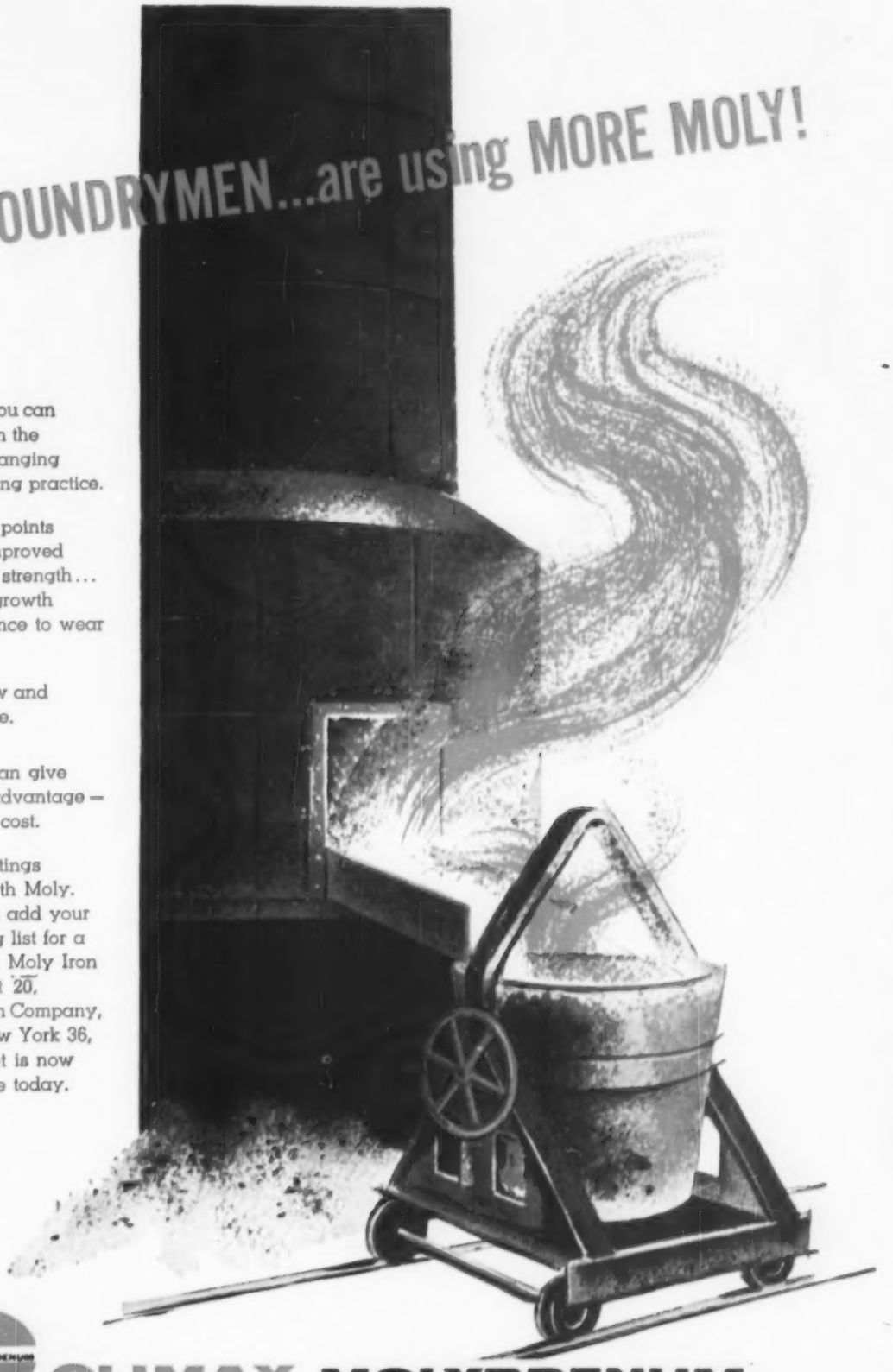
The aluminum was melted in a resistance melting furnace and poured by hand ladle into the permanent mold machine. The cast cover was removed from the mold and trimmed in a shear die.

Stationary displays demonstrated sand and die casting.

Not in the Fabricast exhibit but in a general research exhibit was a working transparent model which demonstrated some of the problems of gate design. The model showed how bubbles formed with poor gate design but not in good gate design in the pouring of Alloy GMR-235.

The Fabricast exhibit occupied 4000 sq ft and products were from the division's plants at Bedford, Ind., and Jones Mills, Ark. This GM division contributes castings to 20 General Motors divisions and to a number of independent firms.

MORE FOUNDRYMEN...are using MORE MOLY!



IT'S EASY TO USE . . . you can add all your **Moly** in the ladle . . . without changing your accepted melting practice.

IT'S POTENT . . . a few points of **Moly** give you improved properties . . . added strength . . . heat resistance . . . growth resistance . . . resistance to wear . . . uniformity.

IT'S AVAILABLE . . . now and in the years to come.

Let **Moly** prove it can give you a competitive advantage — better parts for less cost.

For engineered castings get better results with Moly. If you would like to add your name to our mailing list for a series of leaflets on Moly Iron address Department 20, Climax Molybdenum Company, 500 5th Avenue, New York 36, N. Y. The first leaflet is now ready for you. Write today.

CLIMAX MOLYBDENUM

CIRCLE NO. 120, PAGE 79-80

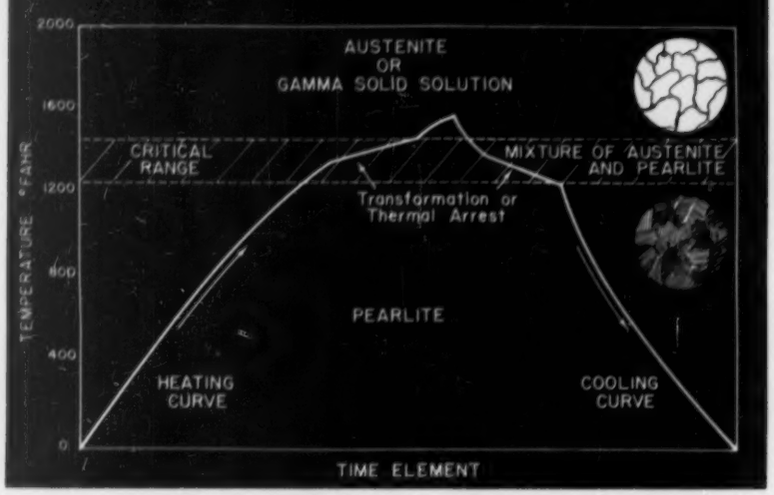


Fig. 1 . . Effect of slow heating and cooling on cast iron structure.

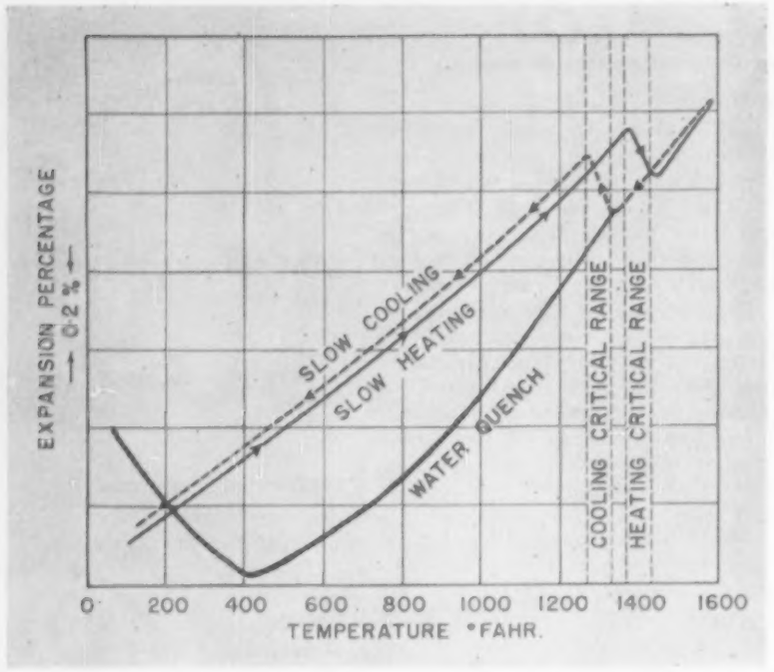


Fig. 2 . . Volume change of cast iron heated and cooled thru critical.

HOW TO HEAT TREAT GRAY IRON

Four ways to help iron castings meet modern industrial demands

■ Once a gray iron casting has solidified the amount, size and distribution of the graphite phase, a vital factor in controlling properties, is essentially defined and resistant to change by any commercial heat treating procedures.

In general, the development of maximum properties is only practical in irons where (1) a good, well-distributed, small graphite flake, and (2) a fully pearlitic matrix have been developed according to improved modern foundry practice. It is only with irons of this character that we can discuss the profound effectiveness of heat treatment and the resultant development of established physical and mechanical properties that can interest and be accepted by the design or materials engineer.

■ **Main objectives** in heat treatment of iron castings include:

1. Annealing for stress relief.
2. Heating and quenching for full hardness.
3. Heating, quenching, and drawing to increase strength and toughness.
4. Surface or local hardening with torch or electric induction heating.

Annealing to improve machinability is often included in these objectives but generally cast irons have free machining qualities which are one of their outstanding characteristics. Any necessity to obtain further improvement, often because of the presence of hard spots, stems from poor selection of cupola metal and such annealing treatment can seriously impair the mechanical properties of the graphite-pearlitic engineering irons. Normalizing, heating above the critical temperature followed by air cooling, has little value or usefulness with iron castings.

Theory of Heat Treatment

The objectives of quench treatments are related directly to the modification of the matrix of pearlite structure and its effect on the properties of the irons.

Slow heating and cooling. Pure iron has a critical temperature at about 1650 F. Below this temperature carbon is essentially insoluble in the iron, termed apha iron or ferrite. Above the temperature about 0.8 percent or more carbon can be dissolved in the iron, termed gamma or austenite. With carbon present the critical temperature is lowered and with the binary system (Fe-C) we find a critical range around 1350 F (Fig. 1)

Thus, on heating a gray iron casting no structural change is evident until this critical range is reached when the alpha iron transforms to gamma and the pearlitic

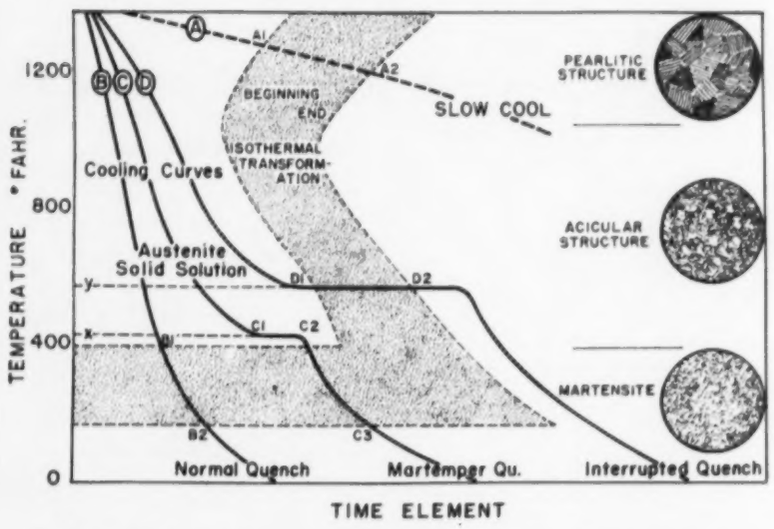


Fig. 3 . . Methods of quenching and their relation to S-curve show variety of heat treatments possible. Curves are for iron-carbon alloy.

carbide is taken into solution with the formation of austenitic solid solution. On slow cooling the simple solid solution of carbon in iron is retransformed to pearlite as it passes down through the critical.

No mention is made of the graphite since this phase essentially takes no part and is not subject to modification by this heat treating cycle.

For simplicity we have initially omitted consideration of the silicon content of cast irons. Apart from founding technology it may be stated that the prime effect of silicon in heat treatment is (a) to raise the critical temperature range and (b) to reduce the stability of the pearlitic carbide.

Slow heating followed by slow cooling through the critical is rarely recommended and in high silicon irons of heavier section, slow cooling through the critical may result in graphitization with separation of some free ferrite and serious impairment of strength and wear resisting qualities of these irons.

Coventional quench hardening. If we should again slowly heat above the critical and then rapidly cool by quenching the pearlite transformation is suppressed and the soft austenite transforms to martensite from about 400 F down to room temperature. Simple expansion and contraction curves can best illustrate these two well known examples of control of phase changes by rate of cooling (Fig. 2).

When an iron casting is heated slowly and progessively, it expands until it reaches the critical range. As the alpha transforms to gamma iron and the pearlitic carbide passes into solution, contraction occurs with increased temperature. Thereafter, normal expansion follows. On slow-cooling the reverse of the cycle takes place.

However on rapid cooling (water quench) the austenitic pearlite transformation is completely suppressed with progressive contraction down to about 400 F when the austenite spontaneously transforms to hard martensite with profound increase in expansion or volume of the casting.

It will be noted that slow heating and cooling results in a slight increase in dimensions of a casting whereas quench-hardening produces marked expansion in the 400 to room temperature range. The latter illustrates why considerable care is necessary in quenching castings of complex shape because of the high quench stresses developed. It also emphasizes why an immediate draw is recommended to reduce the possibilities of spontaneous cracking.

Interrupted quench treatments. Modern heat treatment demands some attention to austempering or interrupted quench treatments. This is most simply portrayed by use of a standard S-type isothermal curve (Fig. 3). The slow cool is typified by curve *A*, the water quench by curve *B*.

A martemper hardening (curve *C*) depends on rapid cooling from about 1575-1600 F through the critical by quenching in a liquid bath at about 450 F, holding for a short period for temperature equalization with relief of thermal stress, and then air cool for the austenite-martensite transformation.

In the austempering treatment the rapid cooling from the austenitizing temperature is effected by quenching in a bath at between perhaps 600 and 750 F, holding until the austenite has completely transformed to the intermediate acicular structure (curve *D*), then air cooling. This treatment provides intermediate hardness values around 350 Brinell with improved toughness and high tensile strength.

C. R. Austin/*Asst. to President*
Meehanite Metal Corp.,
New Rochelle, N. Y.

Figure 3 was given as a standard type S-curve for iron-carbon alloys. It is of interest to reproduce a true S-curve obtained on 50,000 psi engineering iron. The stabilizing effect on the austenite by increasing the temperature of austenitization is clearly shown in Fig. 4.

Dimensions of casting section. In the steel industry recognition of the importance of hardenability (susceptibility to deep hardening) as distinct from maximum surface

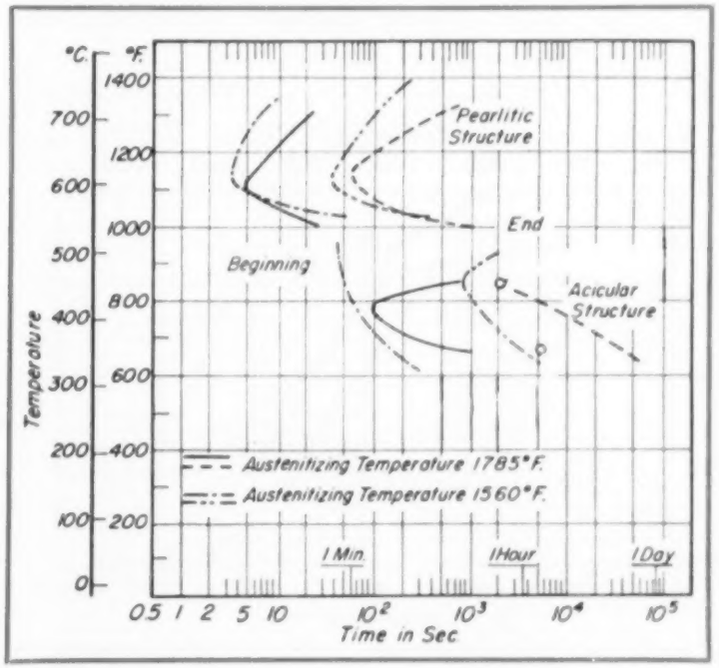


Fig. 4 . . Higher austenization temperature stabilizes austenite.

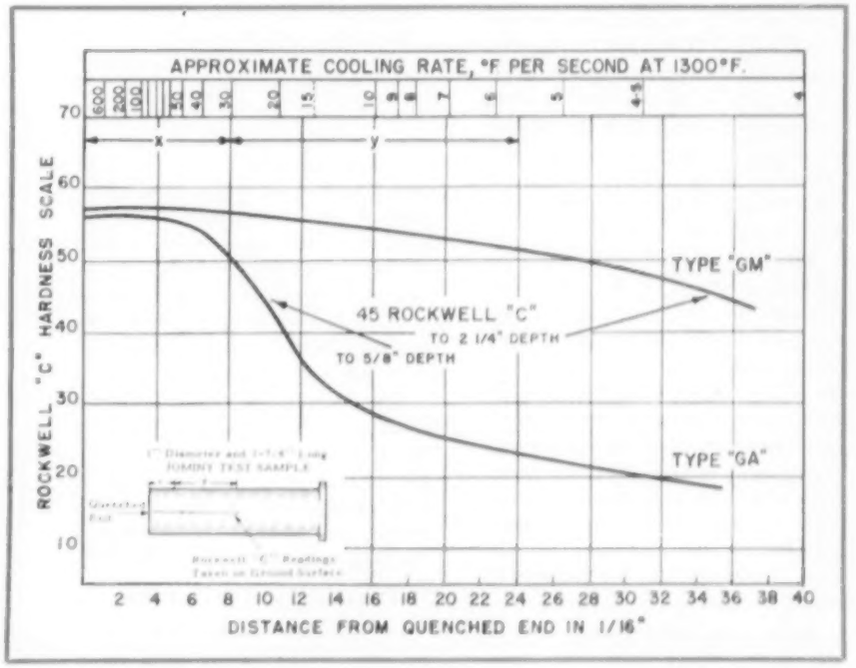


Fig. 5 . . Comparative depths of hardening on process iron castings.

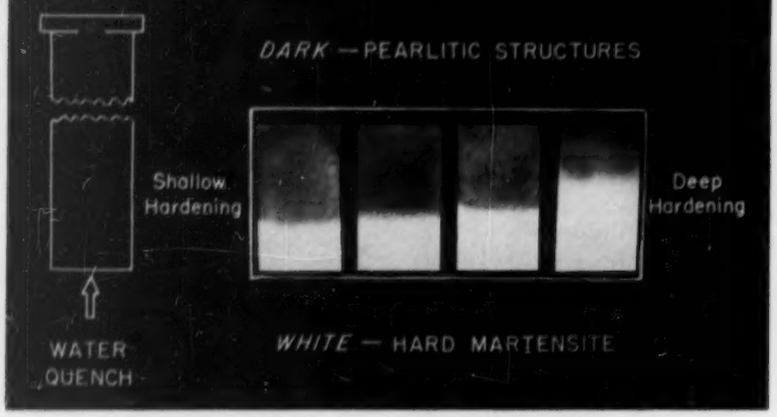


Fig. 6 . . Depth of hardening is shown on polished and etched sections.

hardness has resulted in the use of tests (Jominy hardenability) to determine depth of hardening under standardized and reproducible conditions.

In the Jominy test a 1-in. diameter bar is austenitized above the critical and a water-quench directed on one end of the bar. Rockwell hardness readings made along a ground surface on the side of the bar provide an index of depth of hardening as illustrated with tests on process iron castings reproduced in Fig. 5.

If the test bars are sectioned vertically, polished and etched, the depth of hardening is clearly indicated in Fig. 6. From the Jominy curve chart (Fig. 5) it may be noted that the cooling rate through the critical of the particular iron, must exceed about 25 F per second in order to suppress the pearlite transformation and thus assure decomposition of the austenite to file-hard martensite.

The rate at which a casting cools will be governed by the size of the castings for any given quenching medium—water (severe quench) or oil (a medium quench). Unalloyed irons will usually fully harden only in sections approximately 1 in. or less. For heavy sections, suitable alloying is mandatory in order to reduce the critical cooling velocity. This is necessary to full harden heavier sections and even to promote full surface hardening of heavy sections.

Stress relief treatments. One of the most widely used heat treatments in the gray iron foundry industry is stress relief to eliminate or reduce to a low level the locked-up casting strains resulting from differential rates of solidification in a casting (particularly one of complex shape), and from the restriction to metal shrinkage and contraction of the sand mold or internal cores. Casting stresses are always present but we are frequently not cognizant of the fact unless the stress exceeds the tensile strength of the iron, particularly where this is a matter of poor design (Fig. 7).

Cooperation between foundry and materials engineers can usually overcome this problem with redesign towards section uniformity.

Since we usually demand maximum stress relief in association with minimum impairment of hardness and tensile strength, care must be taken to heat *below* the critical range (Fig. 1). The exact time-temperature requirements will depend on the character of the iron, especially its structural stability below the critical range, but a temperature of 1000-1100 F is usually satisfactory (Fig. 8). The temperature is much more important than the time factor.

The deleterious effect that may result from carelessness in allowing the temperature to encroach into the critical temperature range is well exemplified in Fig. 9. With correct use of stress relief anneal, the results are shown as in Table 1.

Practical Heat Treatment

High strength irons are most frequently subjected to heat treatment for improved properties so it must be recognized that the matrix pearlitic structure is somewhat comparable to that of a carbon tool steel. The manganese content of the irons however may be two to four times that of simple tool steels with increased susceptibility to cracking on heating but especially with high severity of quench.

Accordingly, it is recommended to heat slowly to 1000 to 1100 F whether for stress relief or for subsequent high temperature austenitization prior to some form of quench treatment as previously discussed. If the casting is to be hardened then it is transferred from the low temperature furnace and rapidly heated through the critical range to 1575-1600 F. This temperature is higher than that for tool steels, largely because of the effect of silicon on raising the critical and the effect of manganese is slowing down diffusion rates.

It is important that the pearlite

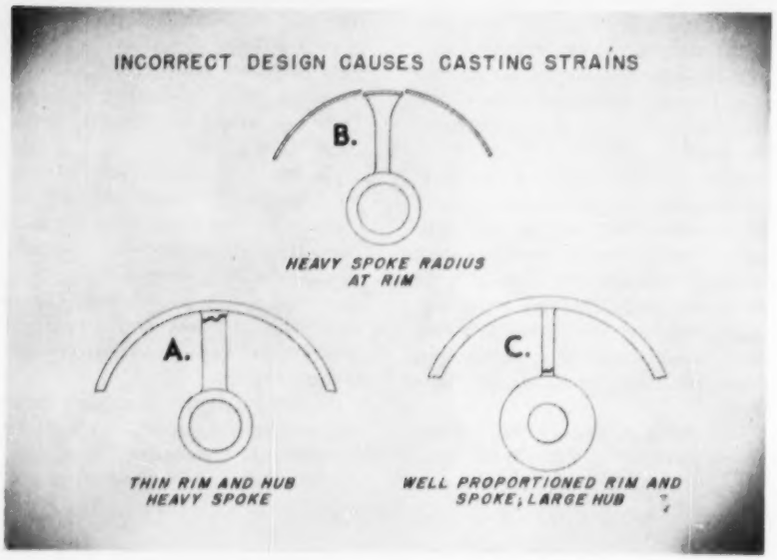


Fig. 7 . . Poor design aggravates liquid-solid shrinkage stresses.

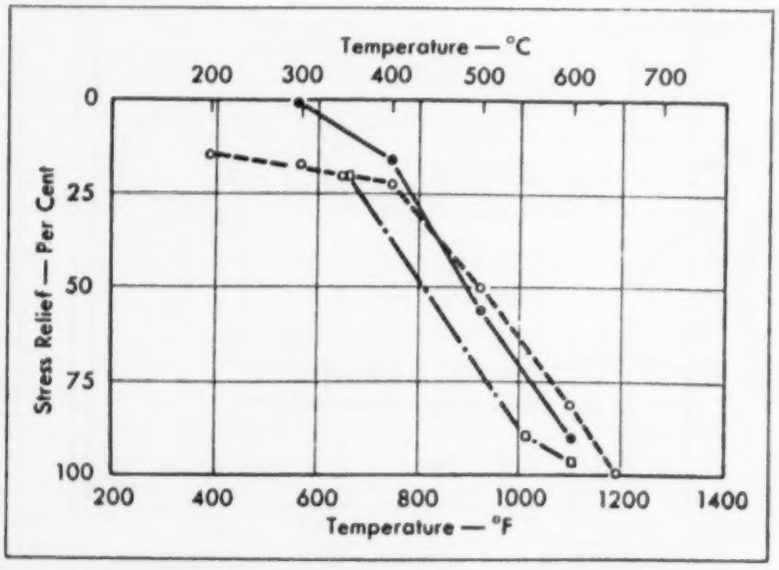


Fig. 8 . . Effects of temperature on stress relief of three irons.

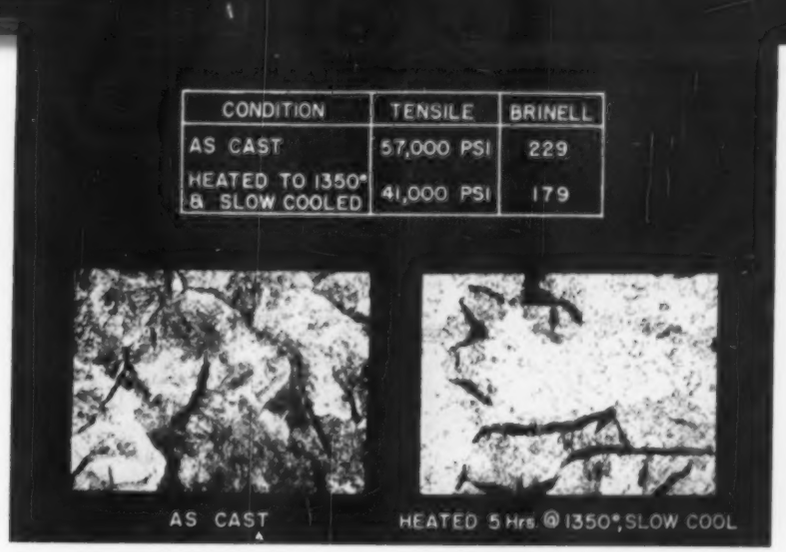


Fig. 9 . . Excessive annealing temperature cuts strength and wear.

Fig. 10 . . Oil quenching high tensile cast iron for full hardening.

carbide be taken into solution completely for full hardening and at the temperatures indicated, holding the casting until it blends with the color of the furnace is a sound practical rule for holding time. Figure 10 shows an oil quench for full hardening which, with castings of suitable section, will provide a file-hard martensitic structure in a high tensile iron.

After quenching it is important to draw back immediately at about 400 F to prevent cracking and maintain full hardness and maximum resistance to wear.

A fact of extreme importance to heat treaters and to materials engineers is that iron castings do not exhibit the simple linear relation between hardness and tensile found in carbon and alloy steels. Thus on drawing above 400 F there is a progressive drop in hardness, as observed in steels. However, the tensile strength and toughness progressively increases as the temperature of draw is raised to 700-750 F. Thereafter, the strength, toughness and hardness traces follow a similar declining pattern (Fig. 11).

Austenitization for martemper and interrupted quench follows the same pattern as in the conventional quench treatment.

In interrupted quench treatments the holding times in the 600-750 F temperature interval are of prime importance but these can be defined accurately only by direct reference to the specific S-curves of the different gray irons.

Table 2 is included to illustrate the effect of holding time on the tensile strength and hardness of a 50,000 psi tensile iron. After 10 minutes at 600 F only a limited part of the austenite has transformed to the acicular structure, the rest decomposed to martensite on air cooling. After 5 hours at 600 F transformation is essentially complete with resultant higher tensile strength at a lower Brinell hardness level.

In some instances electric induction is to be preferred since control of power and current frequency permits an effective rapid heating to a given skin depth, with full surface hardening on quenching. With flame hardening the progressive method, with the work moving relative to the flame (or vice versa), the spinning method or a combination of the two are generally employed in the surface hardening of iron castings.

A great deal of attention has been given to local flame and induction hardening of iron castings but the general basic principles are the same as those given for various quench hardening treatments.

One of the prime factors in favor of surface hardening for increased wear resistance, as opposed to the conventional quench and draw, is the comparative absence of distortion or dimensional changes in the piece to be hardened.

Possibly the largest field of application is in the hardening of the ways and other parts of machine tools subject to excessive wear. Other uses include local hardening of camshafts ,cams, bushings, gears, etc., and the leading edges and parts of dies.

TABLE 1 . . STRESS RELIEF ANNEAL MAINTAINS MECHANICAL PROPERTIES

Treatment	Tensile Strength psi	Brinell Hardness
As Cast	56,200	241
4 hours at 1100 F	55,200	241

TABLE 2 . . INTERRUPTED QUENCH

Test No.	Treatment	Tensile Strength psi	Brinell Hardness
1	Quench 1575 F into salt bath at 600 F for 10 minutes	65,200	357
2	Quench 1575 F into salt bath at 600 F for 5 hours	83,400	321

1.2 diameter section of Type GA Meehanite

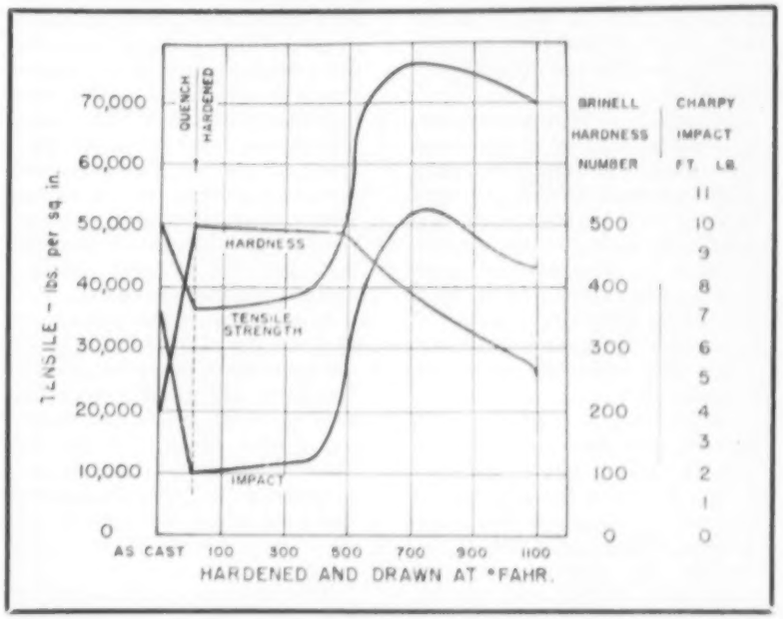


Fig. 11 . . Effect of quench and draw on hardness, tensile, and impact.

W. F. CARN/*Metallurgist*
Precision Metalsmiths, Inc., Cleveland

D. F. MIKA / *Metallurgist*
Precision Metalsmiths, Inc.

INVESTMENT CASTINGS:

4% Carbon Shot Controls Melt Chemistry

Shot permits closer control than other forms of melting stock and reduces amount and number of necessary additions.

■ Melting for investment casting normally is done with small indirect arc or induction furnaces. Although better quality control can be maintained with these types of furnaces, melt size makes it virtually impossible to build alloy steel heats by starting with the primary elements as is usually done in the sand foundry.

The practice in the industry is to produce melts from pre-alloyed shot, pig, or wrought metal bar stock. While pig and bar stock are often satisfactory for non-ferrous and experimental steel melting, the importance of close metallurgical control in production and its effect on the physical and mechanical properties of the castings has led to wide acceptance of specially prepared pre-alloyed shot in the ferrous field.

Several companies now specialize in producing pre-alloyed shot for investment castings. Each heat is certified for chemistry and, when necessary, physical properties. This melting stock makes possible closer control of final chemical analysis assuring better response to heat treatment.

Remelting pre-alloyed ferrous metals, however, does not eliminate loss of some alloying elements and pick up of others. Losses are usually compensated in one of two ways: by remelting a "souped-up" alloy or by adding the necessary elements during the melting operation. To maintain greater flexibility most investment foundries prefer the latter method.

Carbon is probably the most closely controlled element in structural steels since its primary function is to influence hardenability. Alloying elements such as chromium and nickel contribute strength, impact resistance, etc. Most common method for adding carbon is in the form of graphite. Although some loss of the addition is experienced (about 25 per cent), rather good control can be maintained.

We are using a 4 per cent carbon-iron standard in shot-granule form for making carbon additions to steel. The table indicates typical additions of standard for corresponding desired increases in carbon. In the case of induction melted heats, carbon additions can be calculated directly. However, in indirect arc melting, carbon pickup from the electrodes must be taken into account using a melting time-type of alloy parameter.

Silicon is a volatile element which is subject to considerable loss during melting. It is known that silicon in molten steel has a voracious appetite for hydrogen. Therefore, to avoid gassy metal and resultant defective castings, fortification of silicon in master alloys is avoided. Another reason for maintaining low silicon in the prime shot is that it is an excellent deoxidizer and should be added just before pouring for best results.

Minor variations of alloying elements other than carbon in structural steels have little effect on investment castings due to their relatively small size. The ability to control these alloying elements gets better as the alloy content increases. The 400 and 300 series stainless steels are progressively easier to handle in this regard while the cobalt-base and nickel-base alloys cause even less difficulty. Some fortification is desirable to the extent of keeping the less stable elements to the high half of the permitted range. This practice is now standard for alloys used in investment castings.

The physical quality of investment castings, surface finish, dimensions, and often intricate shapes have led the specifications engineer to expect adherence to closer metallurgical control than required from the sand foundry. Sand castings of a structural type generally are specified principally for physical properties. The investment casting foundry, however, usually finds that severe chemical and physical requirements must be met. This presents an inventory problem. In the 400 and 300 series stainless steels, so many specifications exist for the same general type that to stock all these analyses is almost impossible.

In approaching this problem, we analyzed the many stainless specifications to see if closer metallurgical control by our supplier might possibly permit the production of stainless master alloys to a narrower band of chemical range—a band common to all the specifications which we were called upon to comply with. The result has been gratifying.

The economies of the use of steel shot versus bar stock for investment foundry remelting has long been a controversial issue. Undoubtedly something can be said for each. Some of the major considerations involved in the procurement and usage of steel include:

■ **Purchasing.** Although it is true that bar stock at times can be purchased at somewhat lower cost than its equivalent in shot, it is also true that the availability of certain types of bar stock cannot be depended upon for specific chemistry, size, and amount desired. Bar stock generally is made up in mill lots of thousands of pounds. If warehouse lots are low, they need to wait for the mill to supply them, which causes considerable delay.

■ **Handling.** Special handling must be considered in purchasing bar

Carbon Addition Table for Investment Casting Steel Melting

Shows addition in pounds of 4% Carbon-Iron for per cent carbon increase in charges of various weights.

Carbon Increase	Weight of Charge, lb									
%	5	10	15	20	25	30	35	40	45	50
0.20	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0.18	0.225	0.45	0.675	0.90	1.125	1.35	1.575	1.80	1.025	2.25
0.16	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00
0.14	0.175	0.35	0.525	0.70	0.875	1.05	1.225	1.40	1.575	1.75
0.12	0.15	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50
0.10	0.125	0.25	0.375	0.50	0.625	0.75	0.875	1.00	1.125	1.25
0.08	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
0.06	0.075	0.15	0.225	0.30	0.375	0.45	0.525	0.60	0.675	0.75
0.04	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50
0.02	0.025	0.05	0.075	0.10	0.125	0.15	0.175	0.20	0.225	0.25

Add 0.0025 lb of 4% Carbon-Iron for every pound of charge for each 0.01% C build-up required.

4% Carbon-Iron Standard is available in two forms:
- 4% Carbon-Iron for low alloys, constructional steels, 400 series stainless
- 4% Carbon-Stainless for chrome-nickel alloys including 300 series stainless (nominal composition 4% C, 20% Cr, 10% Ni, bal. Fe)

Data furnished by WaiMet Engineering Co.

stock. The bars must be cut to suitable lengths for remelting. They are usually oiled to prevent rust and therefore must be degreased. This extra handling means additional cost.

Shot requires none of this special handling. It is clean and ready for remelting. Special techniques developed by shot manufacturers collapse each sphere, thereby reducing the hazard which was experienced some years ago, with shot sometimes exploding while remelting due to quenching liquid or air entrapment.

A charge can break up the melting crucible when the metal expands during melting unless care is taken in charging an induction furnace, particularly the 50 and 17-lb. variety. Since it is easy to overcharge a crucible with bar stock, a higher crucible breakage is noticed than when using shot. This seems to be due to the fact that during melting, the bars tend to work down between one another while the shot, being round, does not pack but usually is forced up in the center if pressure is exerted at the crucible wall.

■ **Storage and segregation** can become a major operation whenever a large variety of alloys must be handled and melted. Accurate identification is paramount since flexibility demands the melting of up to 15 different alloys a day, covering a range of about 40 common ferrous, cobalt, and nickel-base alloys. Shot is received in clean drums and clearly marked with alloy and heat numbers. These drums are sealed and can be stored together without danger of mix-up. The metallurgical department is constantly aware of the particular heat in use at all times. All guess work in issuing metal is completely eliminated on the part of the stock room.

Drums of shot which have not been opened can be stored conveniently outdoors under tarpaulins or lean-to type protection for extended periods of time without becoming rusty and dirty. This allows more versatility in the stockroom where only metal actually in use need be kept. In this category, shot has one of its greatest advantages over other forms of melting stock.

■ **Chemistry** is probably the chief concern of the meallurgical department. Experience has shown that by controlling the chemistry of the charge, much more accurate control can be maintained over the castings. Shot answers this need better than other forms of stock because the chemical analysis can be specified to casting or special specifications such as universal specifications which have now been written on almost all grades of stainless steel.

The amount and number of additions necessary to maintain the analysis can be reduced considerably by using shot instead of bar stock. This is actually more important than it seems, since it eliminates one more possibility for "the human element."

■ **Remeltability** might be defined as the ease with which one form of metal melts as compared to another. This ease can be measured directly in dollars and cents in the form of labor and operating costs. Direct measurements revealed that the melting time of bar stock was about 75 per cent longer than for shot. The bar stock was ½ in. dia. cut to 4 in. lengths. Both bar stock and shot were equivalent alloy steels.

Faster melting with shot is best explained by the fact that a greater volume of metal can be charged initially. This produces a higher electrical resistance and therefore more heat. Theoretically, shot is the ideal charge for induction melting.

Each department—Purchasing, Receiving, Casting, or Inspection—has seen beneficial effects which could be attributed directly to the use of shot. Moreover, if handled properly, it can and will show an actual monetary saving and an increase in casting quality which is difficult to measure in actual dollars

Shot offers practically no limit to the variation of alloys available. Percentage ranges for the individual elements can be specificed by the foundry according to its particular requirements.

Deoxidation and molten metal detergents are not such a problem in the investment foundry because of the highly controlled, clean melting stock in the master alloys coupled with the size of the heats and the rapidity of the melt-down. However, many of the same problems long peculiar to the sand foundry still arise. The advantage of the very clean, one piece ceramic mold, pre-heated to receive the molten metal, contributes much to the exceptional high quality so characteristic of the physical and chemical properties of the investment casting. However, all the problems inherent in the melting and casting of metals are also encountered in the investment foundry, although to a lesser extent than in sand foundries. Thus, from time to time all the modern knowledge for controlling foundry variables—degassing, fusion detergents, rare earths for controlling grain size, hot-top compounds, mold gas controls, etc.—is used.

Pre-alloyed shot offers induction melting varied yet close analysis, faster melting and ease in storing and handling.

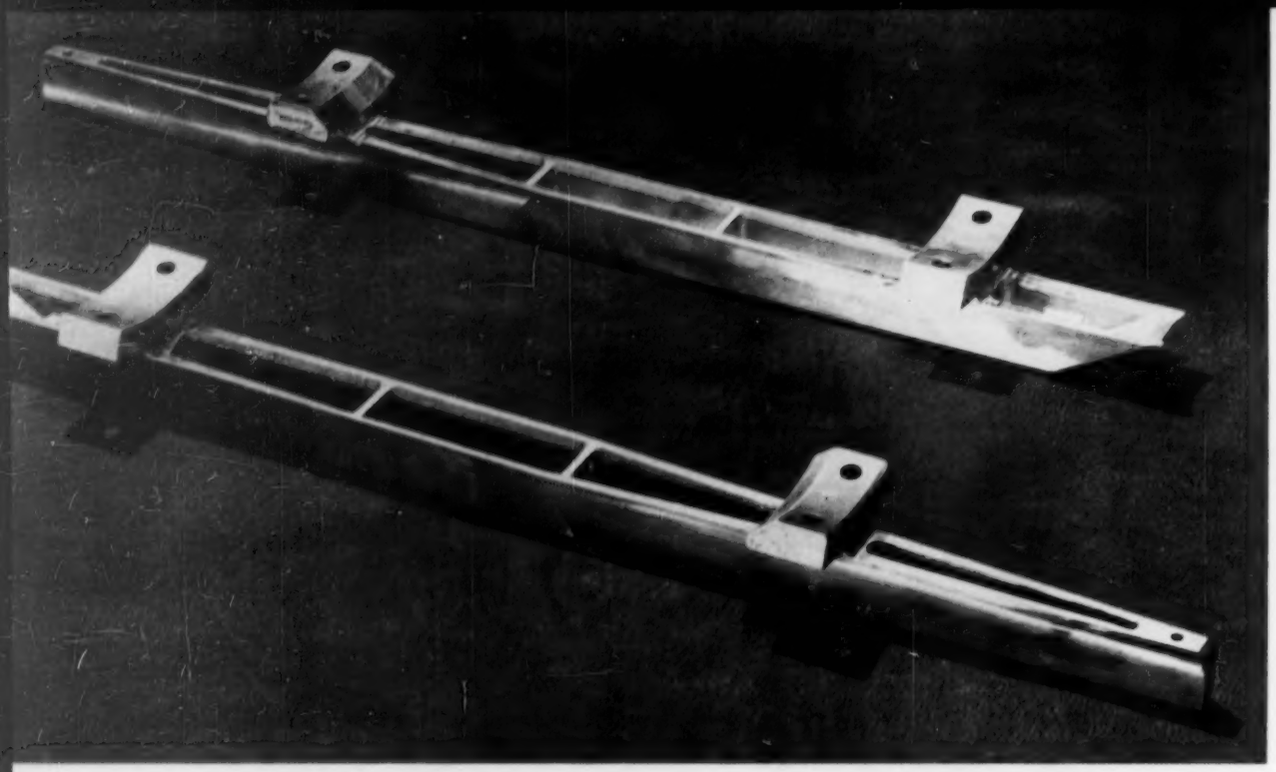


Fig. 1 . . Sand cast aluminum alloy rocket missile fin base

HOW TO SAVE $ ½ MILLION

Premuim casting that replace a machined missile part may save another million

A. J. CARAH/*Asst. Chief Design Engineer*
Douglas Aircraft Co., Inc., Santa Monica, Calif.

■ Castings have long been used where intricate shapes make other fabrication processes unfeasible or uneconomical—though not without some penalty in strength or weight.

In aircraft and missile applications, however, such added weight cannot be tolerated, with the result that castings are not as frequently used in this field. Where they are used, a weight penalty is almost always incurred, since experience with the light alloy cast materials shows variations in strength of as much as two or three to one. Experience shows that actual strengths of most aircraft castings corresponds to about 75 percent of separately cast test bar strengths. To account for this reduction in strength, design loads are multiplied by a casting factor of 1.25 to 1.5.

There is a growing feeling within the aircraft industry that better and more reliable castings can be made. This, coupled with the increasing difficulty of machining many wrought fittings, has led to a number of individual efforts to increase mechanical properties of castings. The Aircraft Industries Association W-70 committee on casting improvement is indicative of the industry-wide interest in producing better castings.

The Douglas Aircraft Co. has been interested in obtaining high strength castings, and particularly in being able to reproduce this higher strength in any casting day in and day out. The following is a description of its efforts in the development and production of one such premium strength casting.

Machining Costs Too High

During the early stages of a development missile, the structural base fitting of the main fin was designed as a casting in 356-T6 aluminum alloy. This part, purchased as a typical aircraft quality casting, proved to be too weak and was replaced with a fitting machined from a 14S-T6 aluminum alloy extrusion. Fig. 1 shows the fitting and Fig. 2 illustrates its relation to the rest of the fin and missile.

The machined extrusion proved satisfactory from a functional and strength standpoint but material costs and machining costs were unacceptably high for quantity production. Ten and one half lb of raw extrusion were required to make a four-lb fitting. In addition, a great deal of warpage was experienced in the machined parts, even though the material had been partially stress relieved by stretching. This imposed additional straightening costs and built up fairly high residual stresses.

Because of these problems and the belief that reliable high strength castings could be produced consistently, a cost and feasibility study of the base fitting as a premium casting was made. Preliminary estimates indicated that if a sand cast fitting could be produced which would carry the required loads, its cost would be about half that of the machined extrusion. The study further indicated that if the part could be made as a permanent mold casting, the cost would be about one-fourth that of the machined extrusion.

Based on quantities then on order, these cost differences represented a total saving of about $1,600,000 by using a sand casting and $2,400,000 by using a permanent mold casting, less development and testing costs.

Design Requirements

The economic stakes in successfully producing such a casting were high but on the other side of the picture the calculated stresses, as shown in Fig. 3, were extremely high. The maximum calculated air loads on the fin produced maximum bending stresses of 56,000 psi (modulus of rupture) across the lug. Because of casting inconsistencies a factor of 1.25 is applied to the design values, which results in a stress level of 70,000 psi.

The wrought fittings were about equal in strength to the attaching bolts; two fittings and two bolts

having failed at about the same load. Since some flight failures of other components indicated the air loads might be somewhat higher than the calculated loads it was deemed advisable to set the casting target strength equal to the average bolt failing load. This stress is 82,000 psi.

A question which naturally arises is why, when stresses are so high, isn't the lug increased in size and the casting wall increased in thickness? Unfortunately, an increase in lug dimensions would result in fairly drastic changes in both internal and external geometry of the missile. Maintaining existing performance standards precluded any increase in weight. Thus, if the fitting were to be cast, its dimensions had to be identical to those of the wrought fitting.

Stress analysis showed that if the tensile and compressive yield strengths were equal, the maximum modulus of rupture attainable for a rectangular section such as the ear is 1.5 times the ultimate tensile strength. Such values are attainable in practice only if the strain at rupture is high enough to allow the section to distort appreciably.

High values of modulus of rupture are sometimes realized due to compressive yield strength being higher than tensile yield strength and to lateral restraint such as provided by webs of the body. Both these conditions were favorable to achieving a high modulus of rupture in this instance.

In short, it appeared feasible to cast a fin base fitting having adequate strength if maximum mechanical properties could be consistently maintained from casting to casting. This requirement meant that mechanical properties of material cut from the castings had to be consistently better than normally expected. In this application the normally allowed properties in the casting of three quarters the cast test bar values could not be tolerated.

Materials and Methods

A preliminary choice of materials and casting methods was made. Sand castings were produced in two alloys characterized by high yield strength, high ultimate strength, and low elongation; and in two

Fig. 2 . . 4-lb fitting was machined from 10-lb extrusion.

other alloys having a relatively lower yield strength, higher ultimate and high elongation.

The high yield strength alloys considered were the standard materials, 355-T6, T61, and T62 and 256-T6, T61, and T62. The so-called low yield and high elongation alloys were XB-216-F and 220-T4. The XB-216-F is an experimental un-heat treated alloy and the 220-T4 is a well known aircraft material. Both of these alloys provide a high ratio of yield to tensile strength, resulting in the ability to redistribute stresses.

Centrifugally cast permanent mold castings were made using three of these four materials, although attempts to cast centrifugally 220 alloy failed due to cracking resulting from sticking in the mold. An attempt was made to control the chemistry in the centrifugal

Fig. 3 . . Economic stakes and stresses were both high.

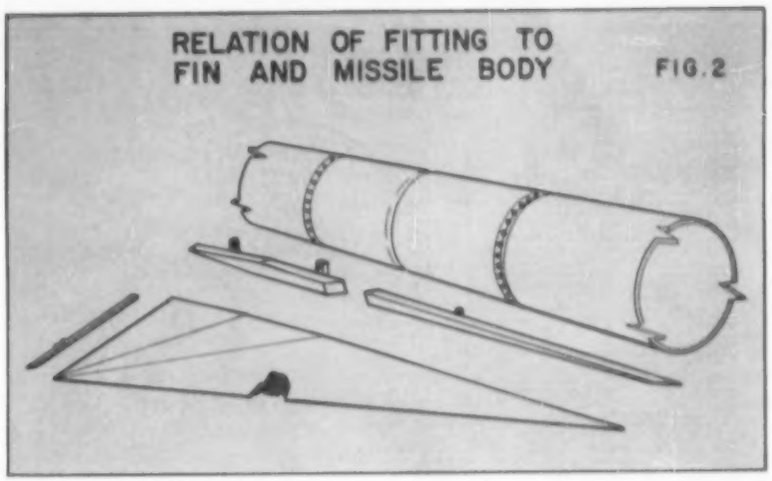
castings. The controlled chemistry, in contrast with the so-called high purity alloys, merely attempted to hold the chemistry to optimum values within the specification limits for highest mechanical properties.

Test Methods

Static tests were then conducted on these fittings. A test jig, illustrated in Fig. 4, was designed to apply the correct ratio of bending moment and shear to the critical lug. The jig was loaded by a precision hydraulic jack anchored about three feet below the fitting to minimize the effect of change of load direction due to fitting deflection. Load was read on a sensitive pressure gage in the jack supply line. All gages used during the tests were calibrated at frequent intervals. The forward lug was allowed to rotate freely to insure that all load was taken by the aft lug.

Sub-size tensile coupons were cut from all the test castings from the heavy section adjacent to the aft lug and from the forward lug.

Fig. 4 . . Critical lug gets bending moment and shear load.



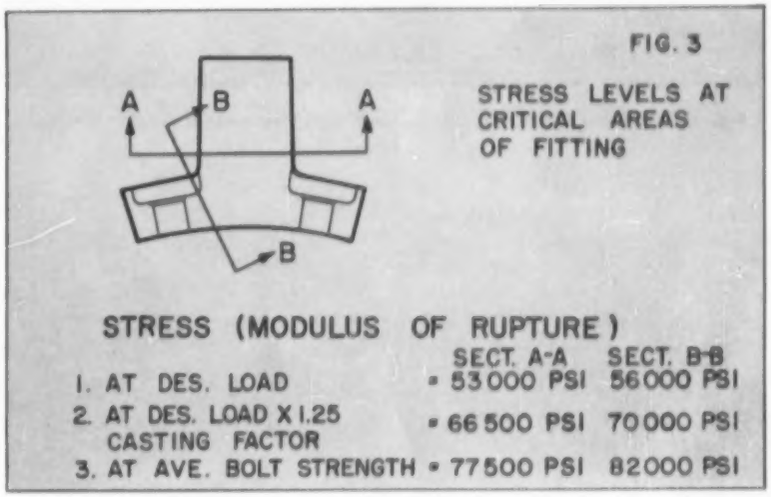
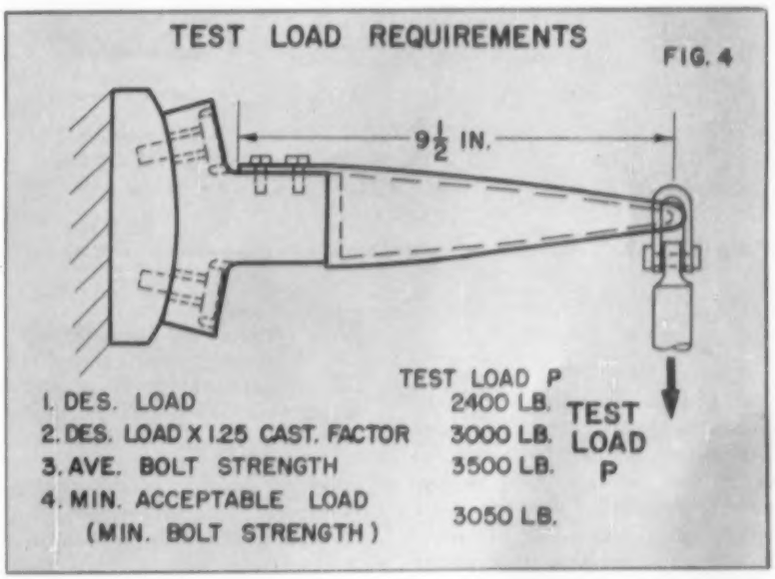


FIG. 3
A
B
A
B
STRESS LEVELS AT CRITICAL AREAS OF FITTING
STRESS (MODULUS OF RUPTURE)
SECT. A-A
SECT. B-B
1. AT DES. LOAD • 53000 PSI 56000 PSI
2. AT DES. LOAD X 1.25 CASTING FACTOR • 66500 PSI 70000 PSI
3. AT AVE. BOLT STRENGTH • 77500 PSI 82000 PSI


TEST LOAD REQUIREMENTS
FIG. 4
9½ IN.
TEST LOAD P
1. DES. LOAD 2400 LB.
2. DES. LOAD X 1.25 CAST. FACTOR 3000 LB.
3. AVE. BOLT STRENGTH 3500 LB.
4. MIN. ACCEPTABLE LOAD (MIN. BOLT STRENGTH) 3050 LB.
TEST LOAD P

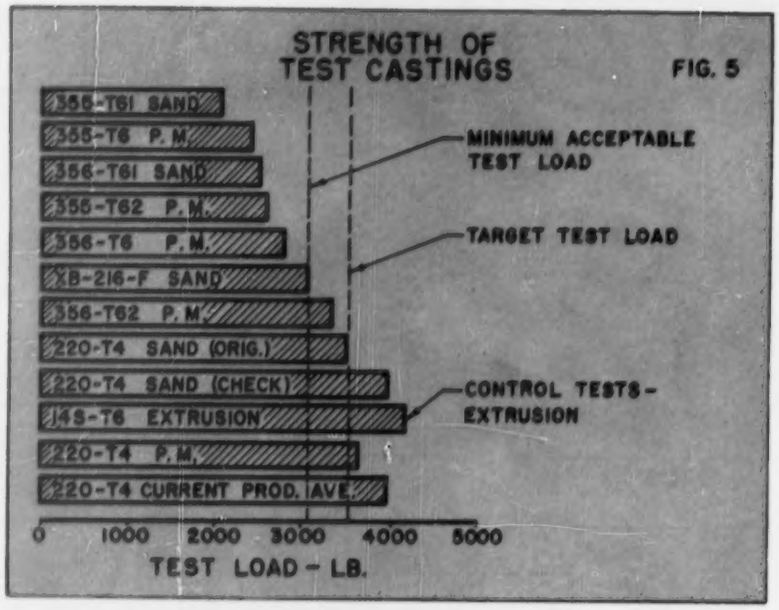


Fig. 5 . . Static tests on sand cast and permanent mold fittings.

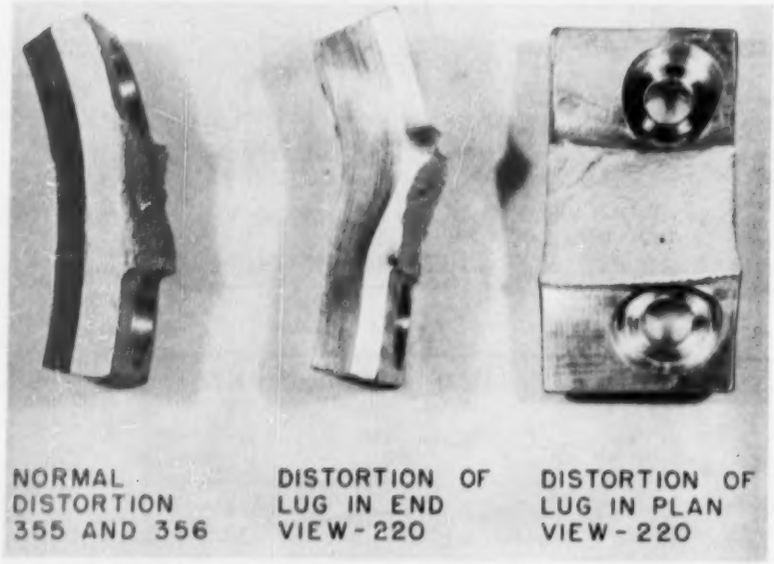


Fig. 6 . . 220 was able to redistribute stresses around concentrations.

TABLE 1 . . COMPARISON OF CASTING PERFORMANCE WITH TEST BAR PROPERTIES

Alloy	Casting Method	Ave Test Load, lb	Coupons from Casting Yield psi	Ultimate psi	Elong %	Cast Test Bars Yield psi	Ultimate psi	Elong %
355-T61	Sand	2040	22,600	28,000	1.6	28,600	37,000	2.0
355-T6	PM	2400	29,500	32,100	0.8	28,400	43,700	7.1
356-T61	Sand	2500	27,400	32,200	2.6	——	34,700	3.5
355-T62	PM	2580	33,600	35,800	0.8	——	——	—
356-T6	PM	2770	28,900	37,900	6.0	27,800	40,000	10.0
XB216-F	Sand	3010	19,400	32,400	7.0	——	33,000	11.0
356-T62	PM	3310	32,800	42,300	7.5	——	——	—
220-T4 (1)	Sand	3500	24,700	37,000	8.0	27,300	50,300	16.5
220-T4 (2)	Sand	3935	24,700	39,600	11.0	26,400	47,500	19.4
14S-T6	Extr.	4150	63,300	70,100	7.6	——	——	—
220-T4	PM	3610	24,600	48,800	20.3	——	——	—
220-T4 Current Prod.	Sand	3940	27,200	53,100	22.3	——	——	—

Test Results

The results of static tests on the cast fittings described above are shown in Fig. 5. Table 1 compares cut coupon and cast test bar properties with actual fitting performance. Because of the very high test bar properties of the 355 alloy, it was expected that this would prove better in the fitting than the 356 which was somewhat lower test bar properties. However, in actual fittings the 356 proved markedly superior to the 355 material.

In both materials, as would be expected, the fittings made by the permanent mold process proved to be substantially stronger than their sand cast counterparts. Parts made from the XB-216-F experimental alloy were stronger than any of the 355 or 356 parts with the exception of two permanent mold cast fittings in 356 which were given the T62 extended aging treatment.

Three sand castings from the first run in 220-T4 proved to be much stronger than any of the others tested. These three averaged 3500 lb test load, exactly the target value. Sand cast test bars and coupons cut from the 220 castings were generally lower in yield and ultimate strengths than those from most of the other castings tested. However, elongation for the 220 was generally higher.

Why did the 220 part, having generally lower mechanical properties, carry a higher load in the fitting than the other alloys tested? An examination of the fittings themselves provided one clue.

Little Casting Distortion

The high yield alloys showed very little distortion of the casting and tended to behave as brittle materials. The 220, on the other hand, showed a great deal of distortion despite the fact that a severe stress concentration existed at the intersection of the lug and the body. This suggested that the higher elongation in combination with the lower yield strength allowed the 220 parts to redistribute stresses around the stress concentrations such that their effect was considerably reduced.

The severity of the distortion experienced by several typical 220-T4 parts is shown in Fig. 6. Notice particularly the elongation in the radius and counterbores and the necking on the tension side of the lug.

Because the 220-T4 fitting met the desired load, a second lot of castings was made to check reproductibility of the initial results. The second series was cast from the same pattern and was treated in the foundry in the same manner as the first lot. A minor modification in machining was made; this consisted of removing some material from the body adjacent to the lug to save weight. The original and revised configurations are shown in Fig. 7.

Gave Startling Results

This second series of 220-T4 castings provided some rather startling results. The average strength was 3935 lb as compared with 3500 lb for the first series. It was not known whether this was due to the configuration change or whether the castings were just better material.

Comparison of sand cast test bars from the two groups showed them to be almost identical in all characteristics. However, both ultimate strength and elongation as determined from coupons cut from the castings were higher from the second lot; yield strength remained about the same. This indicated that probably the increased strength was due to the improved mechanical properties rather than the removal of material.

Average test strengths of 14S-T6 control samples were 4150 lb. Of four fittings tested, two failed at bolts and two fractured. While the yield and ultimate strengths of the 14S-T6 across the extrusion was twice that of the 220-T4 and the elongation was slightly lower, the

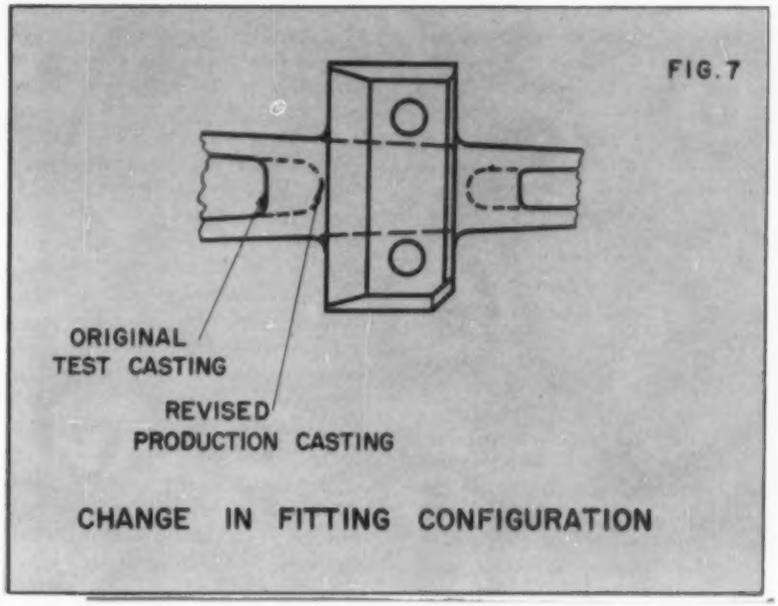


Fig. 7 . . Material was removed from lug area to lighten the fitting.

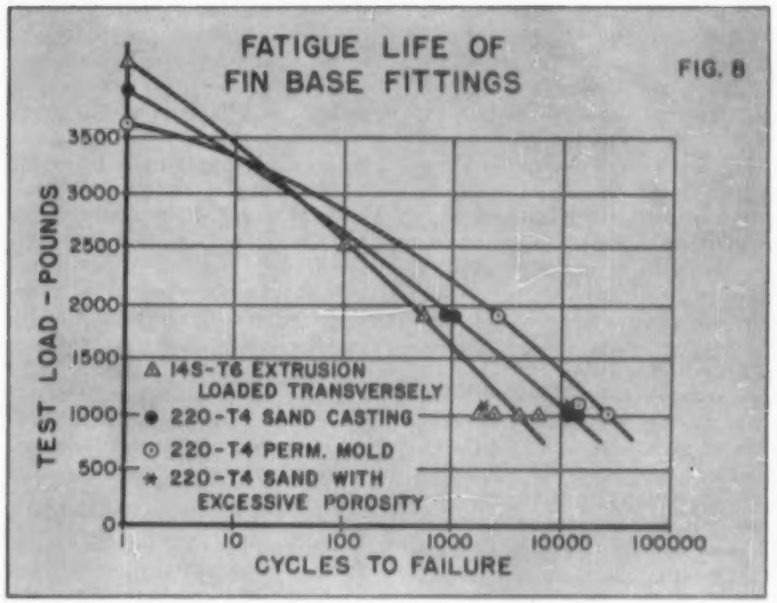


Fig. 8 . . Castings greatly outlast transversely loaded extrusions.

TABLE 2 . . PROPERTIES OF PRODUCTION QUALIFICATION CASTINGS

		Coupons Cut Castings			
Attemp	Test Load lb	Yield psi	Ultimate psi	Elong %	Microporosity
1st	2630	24,500	43,500	16.0	Extensive
2nd	3000	25,100	44,800	13.3	Moderate
3rd	3600	26,200	45,400	13.7	Negligible

extruded fittings were only 5 per cent stronger than the cast fittings.

While the missile fin base fittings had no fatigue life requirements, tests were conducted on a number of 220-T4 sand and permanent mold fittings as a matter of general interest in order to compare fatigue performance with 14S-T6 loaded transversely, as it is in this fitting.

Loading was accomplished with the addition of a cycling valve to the test setup previously described. Parts were loaded at a rate of 2500 cycles per hr.

The sampling taken was very small and results, as shown in Fig. 8, thus cannot be taken as conclusive. However, the results are consistent enough to indicate that for this fitting, in the presence of a severe stress concentration, the castings outlast the transversely loaded extrusions by a considerable margin.

The trend also shows that the 220-T4 permanent mold castings have a greater fatigue life than the 220-T4 sand castings.

Low quality 220-T4 sand castings with excessive porosity were about equal in fatigue life to the extrusions.

On the basis of these tests, it was decided to change production fittings from 14S-T6 extrusions to 220-T4 sand castings and that development would be started on 220 permanent mold castings.

A program was immediately started to qualify the production foundry castings at the required strength of 3500 lb. The first samples submitted averaged 2630 lb. failure load, or about 75 per cent of the required strength. After some modification in gating and risering, a second group of castings developed an average strength of approximately 3000 lb. Further modification to gating, risering and chilling produced castings averaging 3600 lb. in strength. It is interesting to note the changes in mechanical properties that went with these groups, as shown in Table 2.

The cut coupons show a small improvement in yield and ultimate strength, although not nearly enough to account for the considerable increase in fitting strength. Microscopic examination of the area near the fracture showed extensive micro-porosity in the first lot. Porosity was moderate in the second lot and negligible in the qualifying lot.

It was intended to control production casting strength by occasional static tests using a combination of x-ray, ultrasonic and hardness testing techniques to pick the test castings. Those to be tested were generally the worst as indicated by the foregoing nondestructive inspection methods.

Because of almost complete lack of correlation of strength with either x-ray, ultrasonic or hardness, these methods of choosing test sam-

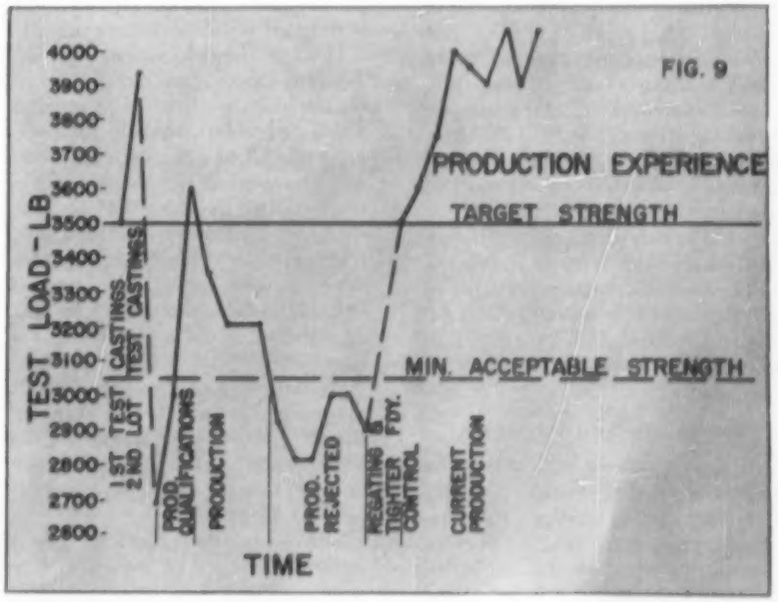


Fig. 9 . . Note that low strengths occurred with increased production.

ples were abandoned in favor of random sampling of one part in 50 castings.

After a few satisfactory production castings, strength began to drop as shown in Fig. 9. Average strength of a number of fittings was approximately 2800 lb and as a result several hundred castings were rejected. It is significant that the low strengths occurred simultaneously with an increase in production rate of about 50 per cent.

Further regating was done to correct this downward trend and more rigid controls were placed on chemistry, fluxing, degassing, temperature of melt and temperature of pouring. As a result of this regating and closer control, the castings now being produced test consistently above 3500 lb averaging 3940 lb. This quality has been maintained for a period of approximately two months and indications are that as the foundry gains experience these values should be reproducible at any time.

Current Development

Because of the additional potential cost reduction and inherently higher production rate, development has been started on three types of precision castings of this part in 220 alloy: semi-permanent mold, full permanent mold, and shell mold. Development work is required as 220-T4 alloy is not in general use for permanent mold castings.

Several semi-permanent mold 220-T4 alloy castings were produced which tested to an average breaking strength of 3610 lb. However, production castings have not met the 3500 lb requirement and are not yet being used in missiles. Work is continuing on this process. Still in an early stage is a program to produce the parts in 220 alloy in a full permanent mold. Shell molding is also being attempted but to date no parts have been made in this manner.

Production Test Procedures

It soon became apparent that the normal time lag through foundry handling, heat treating and machining was too great to prevent several hundred fully machined castings from being rejected if the test samples were not up to strength. A revised sampling method was therefore inaugurated in which each lot of raw castings was held in bond until a test sample picked at random was machined and static tested on an expedited basis. The period from beginning of machining to end of static testing has been held to less than 24 hours in most cases. Lot size is approximately 50 castings and in no case may a lot be composed of more than one heat treat batch. Any lot for which the sample meets the test requirements is immediately released for machining. Lots which do not meet the minimum requirements are rejected in their entirety on the basis of the static test.

Economics of Premium Castings

The economics of producing the fin base fitting under rigid foundry controls and a continuing static test acceptance procedure has raised several questions. What is the cost of development? What is the increased cost per casting and the cost of static tests?

Total development cost to date is about $30,000, including patterns, molds, castings and test time. The premium raw castings cost about 30 per cent more than the same part as a run of the mill casting. Present cost of tests is about 2.5 per cent of total fitting cost. However, this will be progressively reduced to 1.2 per cent and then to 0.6 per cent as sampling frequency is reduced with more experience.

Despite the added costs which amount to approximately 32 per cent of the total cost of producing a run of the mill casting, the complete machined fittings are now one half the cost of the machined extrusion. On the basis of the machining required on the relatively few permanent mold parts produced to date, fittings produced in this manner are expected to cost 22 per cent of the machined extrusion cost.

Actual savings by the aircraft manufacturer to date are approximately $500,000 over and above the development and testing work done. Potential savings are well over $1,500,000.

Obviously, the requirement for premium properties for other castings must be evaluated on the basis of possible gains versus the penalties incurred. Gains may be in terms of dollars of production cost, smaller size in limited space, or weight savings for which the aircraft industry pays a high premium. Penalties, of course, are development cost, casting cost premium and possibly production test or special inspection costs.

Conclusions

Increased use of castings in missiles and aircraft applications will come about when foundries can produce consistent and reliable high strength castings having a minimum variation in strength.

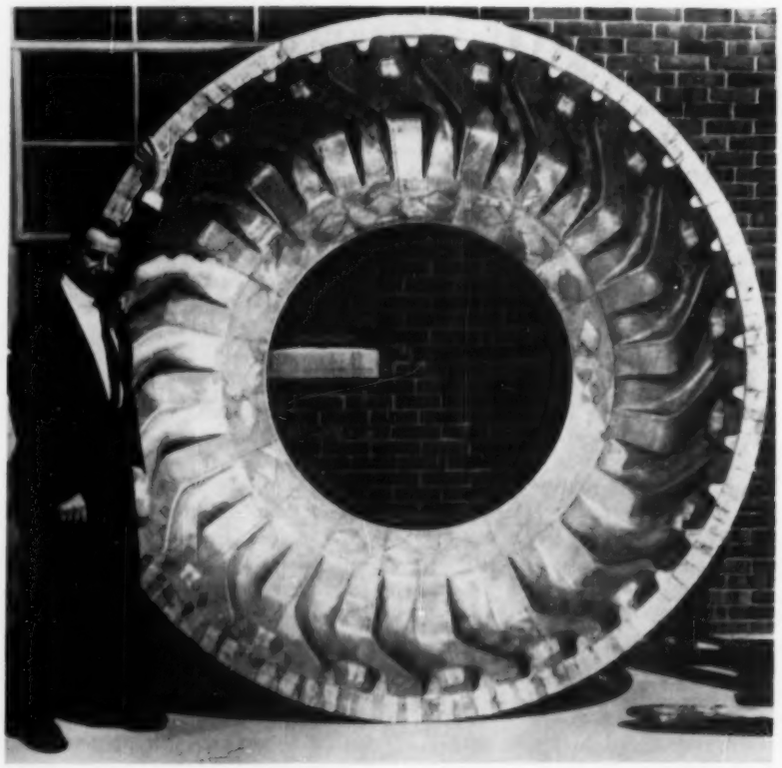
The development and production of the premium strength fin base casting discussed indicates the feasibility of consistently producing higher than average strength castings where weight and economic considerations show such castings to be worthwhile.

The successful production of such castings requires that more than normal time and effort must go into their development and the foundry must consistently control their processes to closer limits than is presently done. Further, the purchaser must be willing to pay a premium price for premium strength. Such a cost increment need not be prohibitive, however.

Further work needs to be done to determine what foundry practices most strongly influence consistency of the product and within what ranges these practices must be controlled to maintain high strength and reliability.

The most rapid progress toward consistently high strength castings will be achieved by the practical production of such parts on a slowly accelerated basis; utopia will not be achieved overnight.

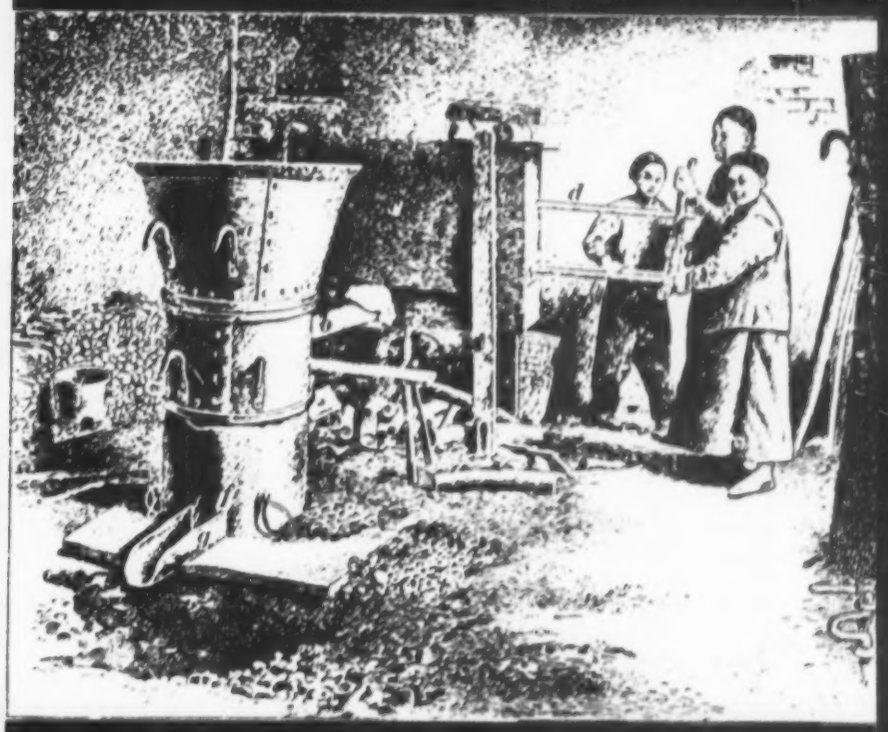
Morris Bean Casts Largest Tire Mold



The world's largest cast tire mold was recently shipped to Goodyear Tire & Rubber Co. from the Yellow Springs, Ohio foundry of Morris Bean and Co. Made of aluminum and weighing 1800 lb, this cast tread ring, and its mate, will be used at Goodyear to make 37.5 by 33 tires for road building units.

SPECIAL CUPOLAS and ACCESSORIES

developments in special cupolas are overcoming past deficiencies and are resolving problems created by castings buyer demands



A MODERN CASTINGS BONUS

Cupolas have come a long way since early design changes expected to make a better smelting furnace out of the traditional forge created a better iron melting unit instead!

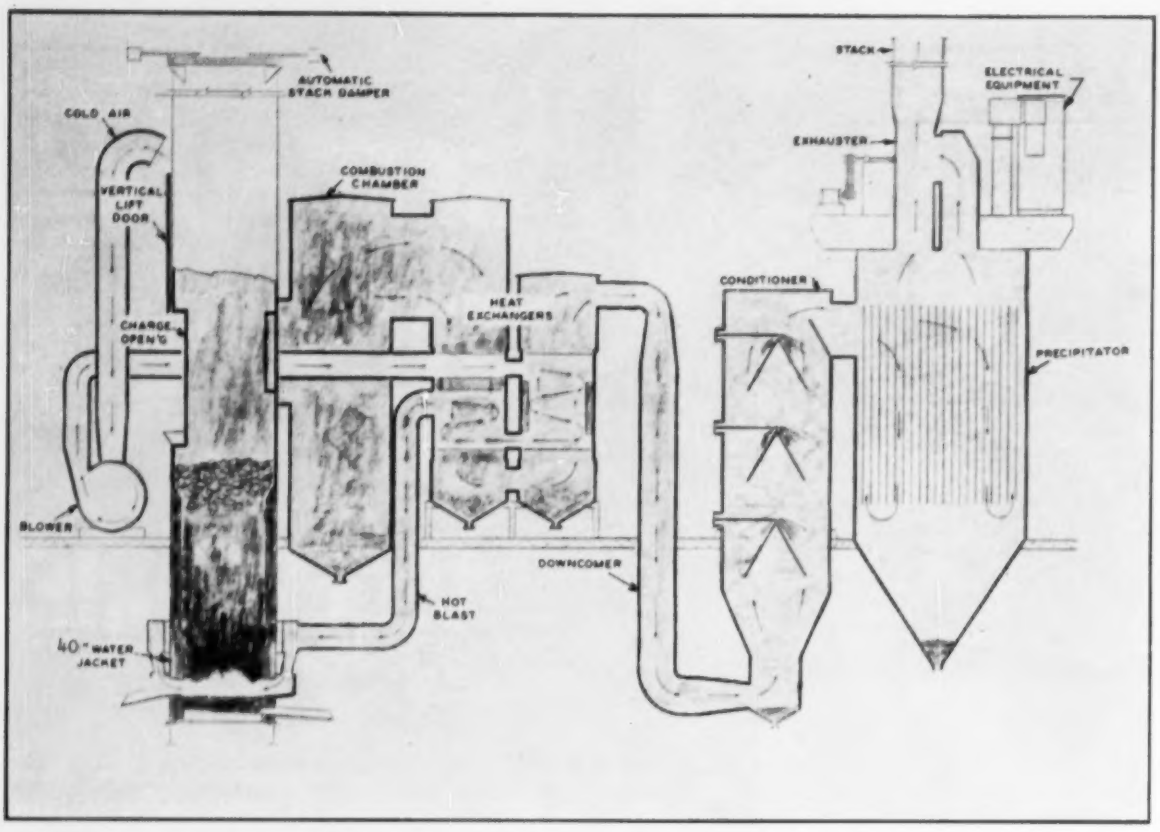


Fig. 1 . . Installation of latest side charged cupola with water cooling, hot blast, electrostatic precipitator.

■ The conventional acid lined cupola has been the traditional melting unit in the foundry industry ever since its inception.

Over the years, much thought has been given to operating principles, but basic principles and design remain the same and consequently we are still handicapped in our ability to govern oxidation rates and metal/slag reactions so as to substantially eliminate melting losses and perform such metallurgical refinements as desulphurization and deoxidation.

These deficiencies constitute an additional handicap in that they limit the degree to which low cost raw materials, such as scrap iron and steel scrap, can be used, necessitating substantial amount of expensive pig iron in order to meet carbon, sulphur, and phosphorus requirements. Furthermore, it is frequently not recognized that present cast iron specifications are at least to some extent governed by the ability of the cupola to produce rather than by ideal metallurgical requirements.

Coupled with the above limitations is the fact that the overwhelming majority of cupolas in use today are limited in their ability to operate for periods much over 18 hours due to excessive refractory erosion, thereby necessitating the installation of duplicate units whenever continuity of metal supply is a requirement as is the case in most production foundries.

These limitations have in the past not been looked upon as a serious handicap but rather an established fact. The rapid progress made in foundry metallurgy during the past decade coupled with steadily rising costs of raw materials and labor have, however, brought about requirements which are beyond the capability of the present cupola.

Modified Acid Lined Cupolas

Although this discussion is primarily concerned with new types of cupolas, the latest developments in design and operation of some conventional acid lined cupolas are sufficiently significant to warrant their inclusion here.

■ **Side charged acid cupola.** Figure 1 shows an installation incorporating the latest thinking in a side-charged acid lined front slagging cupola. This installation is composed of a conventional cupola stack (102 in.) which has been modified to include automatic stack dampers. In addition, the shell is fitted with an internal sectional water jacket extending upwards 36 in. from the tuyere level. Although the stack is side-charged by means of a skip hoist, a counter balanced sliding door operating vertically can be closed between charges.

A blast recuperator consisting of a combustion chamber and a heat exchanger for preheating the incoming blast as well as a conditioner and an electrostatic precipitator for the removal of solid particles from the effluent gases completes the unit.

In the operation of this cupola, an acid lining in the form of brick

or monolithic covers the coolers to a depth of about 8 in. at the start. Although the water coolers appreciably decrease the rate of refractory erosion, it is interesting to note that toward the end of a full day's campaign only a thin layer of refractory or slag covers the coolers and that this layer remains fairly constant once equilibrium has been reached. No attempt is, however, made to operate this installation in excess of 18 hours.

The effluent gases from the cupola are burned in the combustion chamber and then passed through the heat exchanger, thereby preheating the incoming blast air to a temperature of 600 F maximum. The products of combustion from the recuperator then go through a water vapor conditioning chamber for the purpose of cooling and ionization prior to entering the electrostatic precipitator.

In this latter unit the remaining fines are precipitated out of the exhaust gases, the coarser particles having settled in the bottom of the various prior components of the system through gravity. Each one of these components is fitted with a hopper which by means of automatic valves continuously discharges the solids collected into a sluicing system.

The complete unit operates under a slight negative pressure controlled by means of an exhaust fan in conjunction with the precipitation unit. All the various control mechanisms for the installation are interlocked and operated from a central control board.

▪ **Top-charged acid cupola.** Figure 2 shows an installation which is fully enclosed with charging performed through the top of the stack rather than through the conventional side opening. This is accomplished by means of a pair of refractory lined lids covering the top which are moved horizontally by hydraulic units at the time of charging. A special cylindrical cone-bottom bucket is fitted at the lower end with a plastic weighted curtain extending below the bucket. This creates a seal in a cylindrical water trough on top of the cupola when in charging position.

In charging, the bucket is elevated by a skip hoist. While in travel, a steel cover is automatically placed on top of the bucket to form the upper seal. When in charging position, the lower part of the bucket is sealed by the curtain. The sliding doors are next opened, the cone lowered, and the charge dropped into the stack. Following this, the cone is raised, the sliding doors closed, and the bucket picked up by the skip hoist.

In a manner similar to the previous unit, this cupola is also fitted with internal water coolers which are covered with refractory.

The effluent gases from the cupola are passed into the combustion chamber of a recuperative system, but may also be by-passed into the open through a relief stack. This system differs from the one previously described in that the combustion chamber and heat exchanger are combined in one unit. From the recuperator, the products of combustion go through a vertical wet

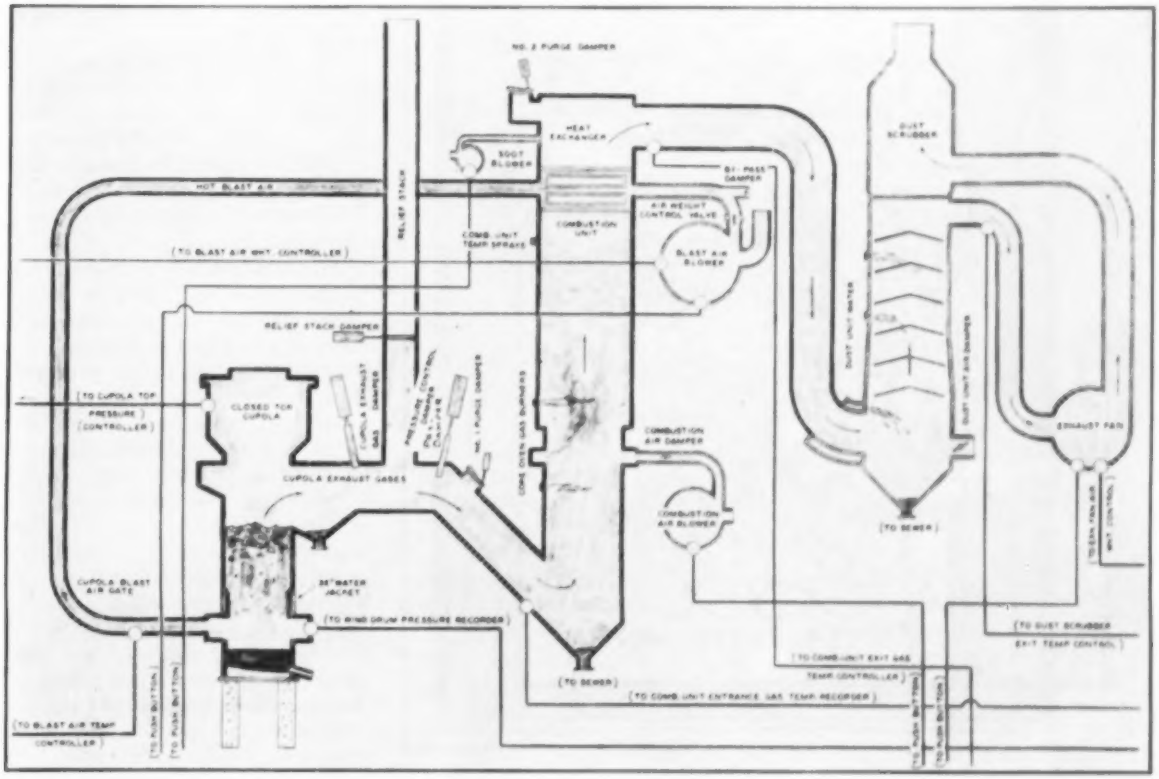


Fig. 2 . . Advanced top charged acid lined cupola has internal water coolers, blast heater, and wet scrubber.

scrubber for the removal of fines and are then exhausted into the atmosphere by means of a blower. The various units of the system are again provided with automatically discharging collection hoppers in which the coarser particles are separated out.

The benefits derived from the innovations incorporated in these installations are to be found in decreased melting losses as a result of improved control, and increased efficiency through better utilization of the fuel, as well as decreased refractory consumption. In addition, the methods adopted for cleaning the waste gases have reduced the ejection of objectionable dust particles into the open by about 95 per cent.

Although the installations described above constitute a distinct departure from conventional design they do not permit much freedom in choice of raw materials nor the control of deoxidation and desulphurization.

Before discussing modifications necessary to overcome present limitations, it may be helpful to review combustion.

Metallurgical reactions. It is well-known that inside of the cupola, various zones of reaction exist and that the relative degree of control exercised over these reactions governs the quality of the end product. Of more importance, however, in connection with present problems is the fact that by proper procedures these reactions may be modified and altered to perform a variety of metallurgical functions not generally associated with conventional cupola operations.

Four definite zones exist. From top to bottom these are:

(a) Preheat Zone
(b) Reduction Zone
(c) Oxidation Zone
(d) Metal/Slag Reaction Zone

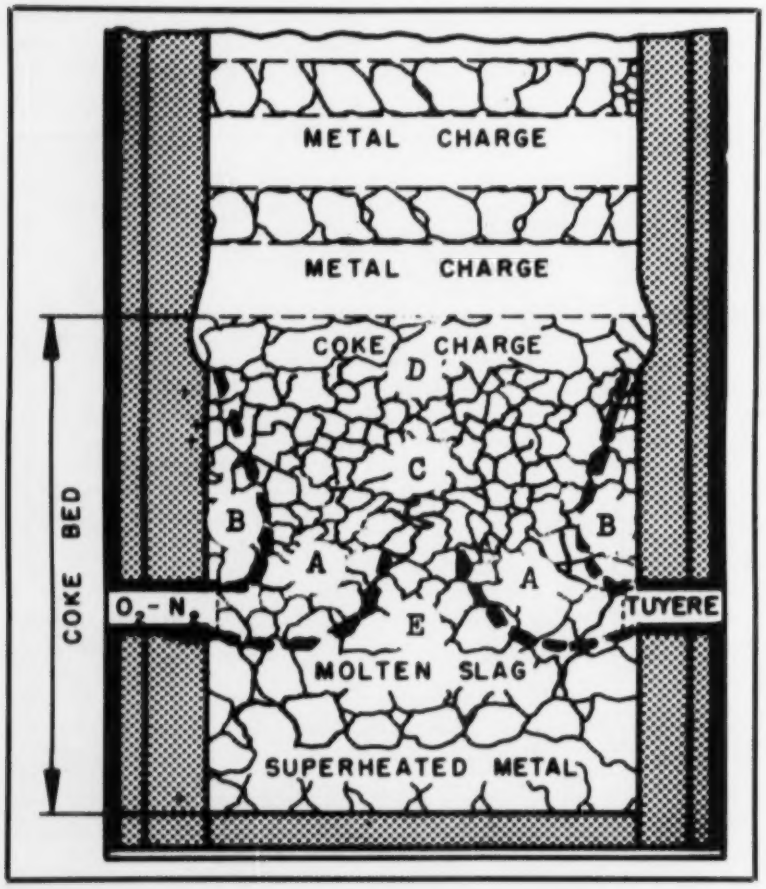


Fig 3 . . Usual combustion conditions in conventional cupola: A—CO_2 and O_2; B—high O_2 to CO_2 ratio; C—CO_2 and CO; D & E—high CO to CO_2.

When the air enters the cupola through the tuyeres (Fig. 3), the oxygen combines with the carbon of the incandescent coke to form carbon dioxide: $C + O_2 \longrightarrow CO_2$ (+ 14,550 Btu/lb of carbon).

This reaction results in the liberation of the large amounts of heat required for melting.

In the presence of excess carbon at the proper temperature, however, CO_2 is not stable but will rapidly pick up an additional carbon atom to form carbon monoxide: $CO_2 + C \longrightarrow 2CO$ (−5850 Btu/lb of carbon).

This reaction absorbs over one third of the heat developed in the first reaction.

In view of the oxidizing and heat liberating nature of the CO_2 reaction and the reducing and heat absorbing nature of the CO reaction, it becomes evident that the control of such pertinent factors as melting rate, temperature, metallic losses, carbon, etc. depends to a great degree upon our ability to govern the extent and relative level of the areas in the cupola where these reactions predominate, as well as the speed with which they reach completion and the degree of such completion.

It must be recognized that the combustion behavior of carbon in the cupola is not entirely dependent on chemical considerations but is also influenced by physical factors such as temperature, coke size, wind velocity, relative coke to air ratio, etc.

For combustion to occur, intimate contact must first be established between the carbon and the oxygen. Once this is obtained, the resultant CO_2 reaction proceeds, first at chemical reaction rates. As more heat is liberated thereby increasing the temperature, the speed of the reaction increases and becomes more and more dependent upon physical factors. The influence for instance of variations in coke size becomes evident by the fact that the smaller the coke, the larger is the surface area of reactive carbon and the shorter is the time required to reach temperature. Consequently, smaller coke size increases the reaction rate. Similarly, increased wind velocity results in a lowering of the temperature because of the cooling effect on the

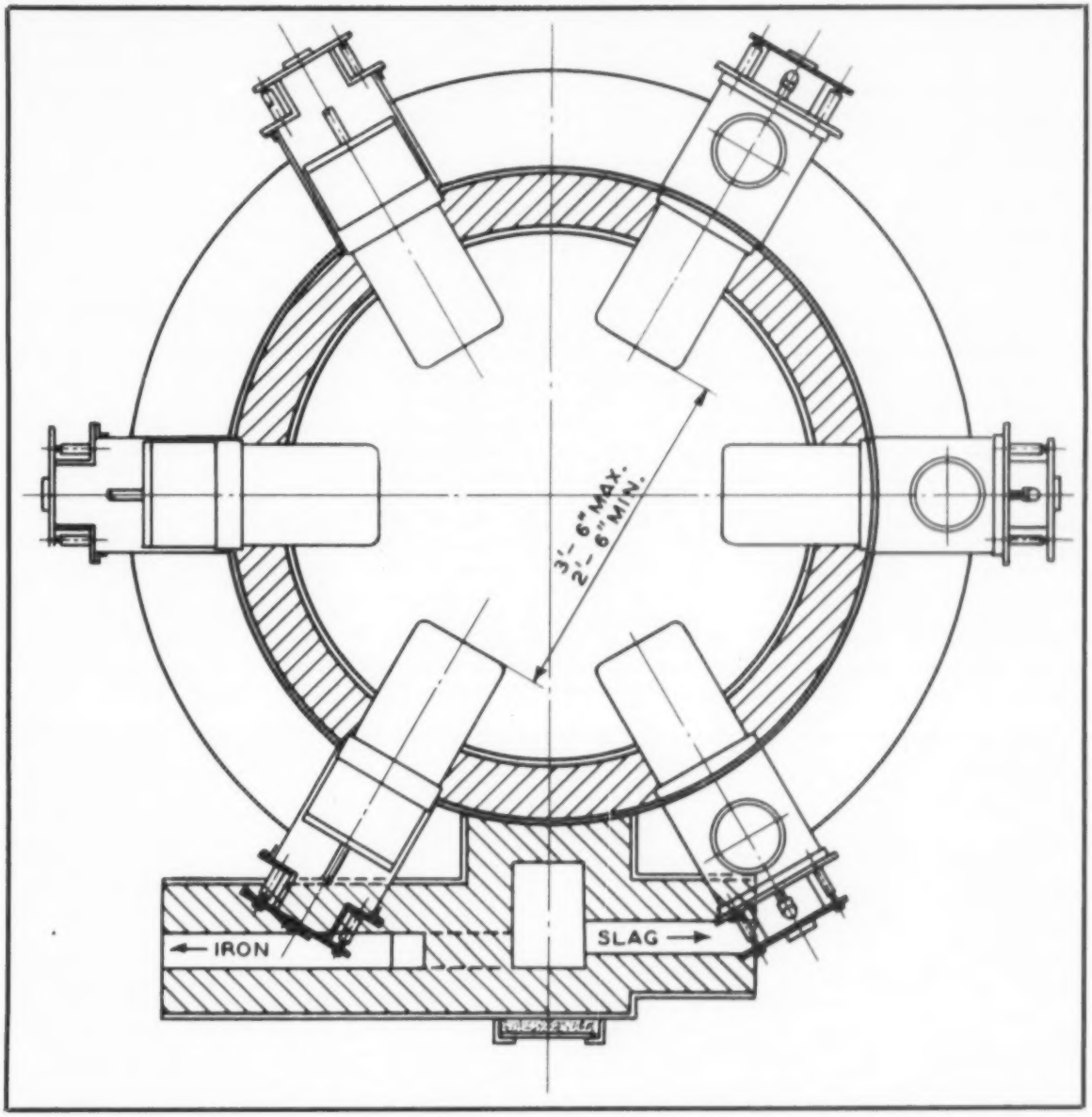


Fig. 4 . . Water cooled projecting tuyeres combine combustion to concentrated zone, minimize free oxygen.

coke, thereby decreasing the reaction rate.

The conditions surrounding the CO reaction are governed by similar variables. Beginning at the upper level of the oxidation zone where high temperatures exist, the reaction proceeds first at a very rapid rate depending largely upon physical factors. The endothermic nature of this reaction, however, coupled with the rapid transfer of heat to the descending burden, gradually lowers the temperature of the gas phase and consequently the reaction rate, until a point is finally reached where the reaction ceases. The composition of the gas phase—the relative $CO:CO_2$ ratio at this point—represents that of the effluent gases and is an important indicator of cupola conditions.

Having established the manner in which carbon and oxygen react with each other in the cupola, it can now be concluded that on the basis of an initially correctly balanced iron-coke-air ratio:

a) Increasing the air volume at a constant coke ratio results in lower $CO:CO_2$ ratio, increased melting rate, but colder metal.

b) Increasing the coke ratio at constant air volume results in higher $CO:CO_2$ ratio, decreased melting rate, but hotter metal.

c) Decreasing the coke size at constant coke to air ratio results in higher $CO:CO_2$ ratio, increased melting rate, and hotter metal.

d) Increasing the blast temperature at constant coke to air ratio

results in higher $CO:CO_2$ ratio, increased melting rate, and hotter metal.

In analyzing the above factors, it is apparent that by proper manipulation, the gas phase of the operation can be regulated so as to produce a variety of conditions required for specific metallurgical functions. The degree, however, to which this can be accomplished depends, as already pointed out, on our ability to control the rate of reaction, as well as the extent of the areas where they predominate.

Referring again to the sectional view of the cupola shown in Fig. 3, it will be seen that combustion does not progress uniformly across the cupola, but that different conditions exist between the center and the outside as a result of the resistance of the coke to the free flow of the air and the upward direction of the gas phase, as well as the cooling effect produced.

Immediately in front of the tuyeres CO_2 and O_2 exist. But, whereas toward the center and slightly upward the reaction rapidly reaches completion, an area high in free oxygen remains just above the tuyeres and extends up along the wall. Although this zone always produces oxidation, it follows that large areas of free oxygen exaggerate this condition. Considering metallic losses and the severe refractory erosion produced by high iron oxide slags, it is evident that our efforts must be directed toward restricting the sphere of influence of O_2 and CO_2. Much can be accomplished in this direction by promoting high reaction rates through increased coke ratio and blast temperature, thereby shortening the reaction zone. Certain modifications to the tuyere design are also indicated.

Turning for a moment to the reduction zone, it will be seen that the relative composition of the gas phase in this zone (the $CO:CO_2$ ratio) and its extent are entirely a function of the conditions established in the combustion zone, and accordingly governed thereby.

In the area below the tuyere level, reducing conditions predominate because of high temperatures and the absence of free oxygen. Consequently, the oxidation of the metallics encountered in the combustion zone is reversed to some extent in this area. The degree of such reversal depends upon the relative $CO:CO_2$ ratio, which is largely governed by the combustion zone, and the time of exposure to the reducing gas, i.e., well depth.

Additional factors. It is well-known that higher carbon pick-up can more readily be attained in cupolas operating with basic slags than with acid. This is probably due to the rapid fluxing and removal of the ash in the coke, which is acid in nature, thereby increasing the available active carbon surface area. In addition, the non-wetting character of basic slags relative to coke further promotes this condition. The degree of carbon pick-up therefore becomes a function of the basicity of the slag in addition to previous considerations.

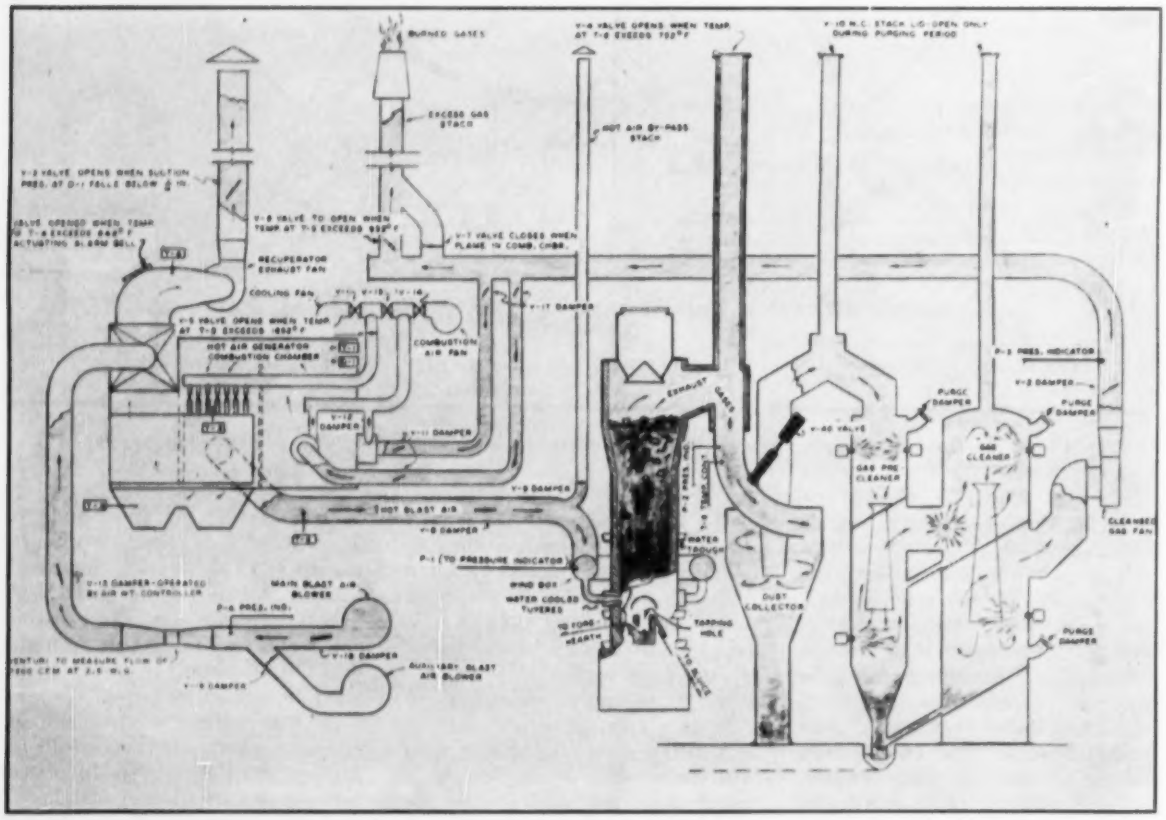


Fig. 5 . . Metallurgical blast cupola incorporating preferred design principles outlined in story.

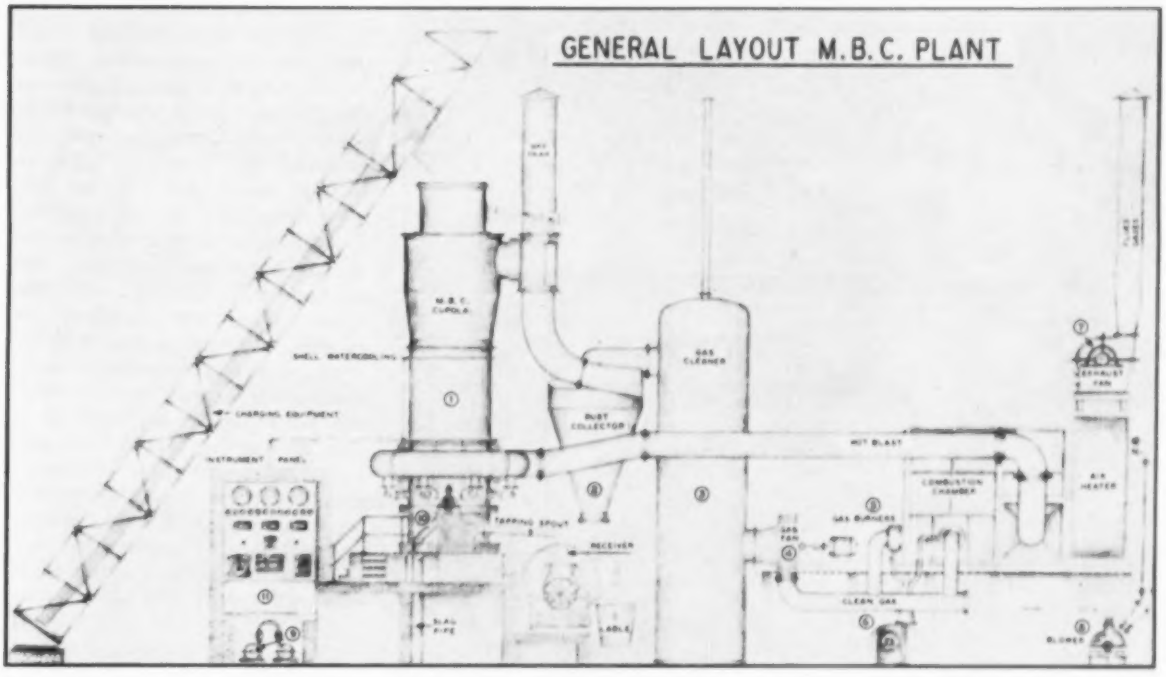


Fig. 6 . . General layout and charging system of metallurgical blast cupola shown in Fig. 5.

From this, it must be concluded that modifications to the cupola are desired which will allow the use of entirely synthetic slags which can be governed to perform specific functions without the danger of contamination from lining erosion and uncontrolled amounts of metallic oxides.

In addition to greatly improved carbon control, this type of operation will make possible substantial desulphurization which is predicated on operating with truly basic slags. This will constitute a decided advantage over the conventional acid cupola where little can be done relative to sulphur, the amount of which, therefore, primarily becomes a function of the sulphur in the coke and to some extent the metallics. Much has been said about the use of fairly high amounts of limestone in acid cupolas for sulphur removal, but such practice is limited in its scope and carries with it the penalty of a decided increase in lining erosion.

According to Rocca, Grant and Chipman the removal of sulphur is a two stage reaction in which:

a) The metallic sulphides from the metal first dissolve in the slag until equilibrium is reached between the amounts in the slag and the metal:

$$FeS\ (Metal) \rightleftarrows FeS\ (Slag)$$

b) These sulphides then react with the lime in the slag to form iron oxide and calcium sulphide:

$$FeS + CaO \rightleftarrows FeO + CaS$$

As this latter reaction can only take place when an excess of calcium oxide is present, and the iron oxide content of the slag is low, the significance of the conditions outlined above becomes evident.

It must be pointed out that an adequate depth of such slag maintained at a constant high temperature and fluidity is necessary in order to insure the required metal to slag and slag to coke reactions. Careful consideration must, therefore, be given to the well depth as well as refractory.

In light of the above discussion, it becomes apparent that by certain modifications to design and operational technique, present limitations can be overcome.

The modifications must permit:

a) A concentrated combustion zone able to produce very high temperatures.

b) Complete freedom in formulating the slag composition.

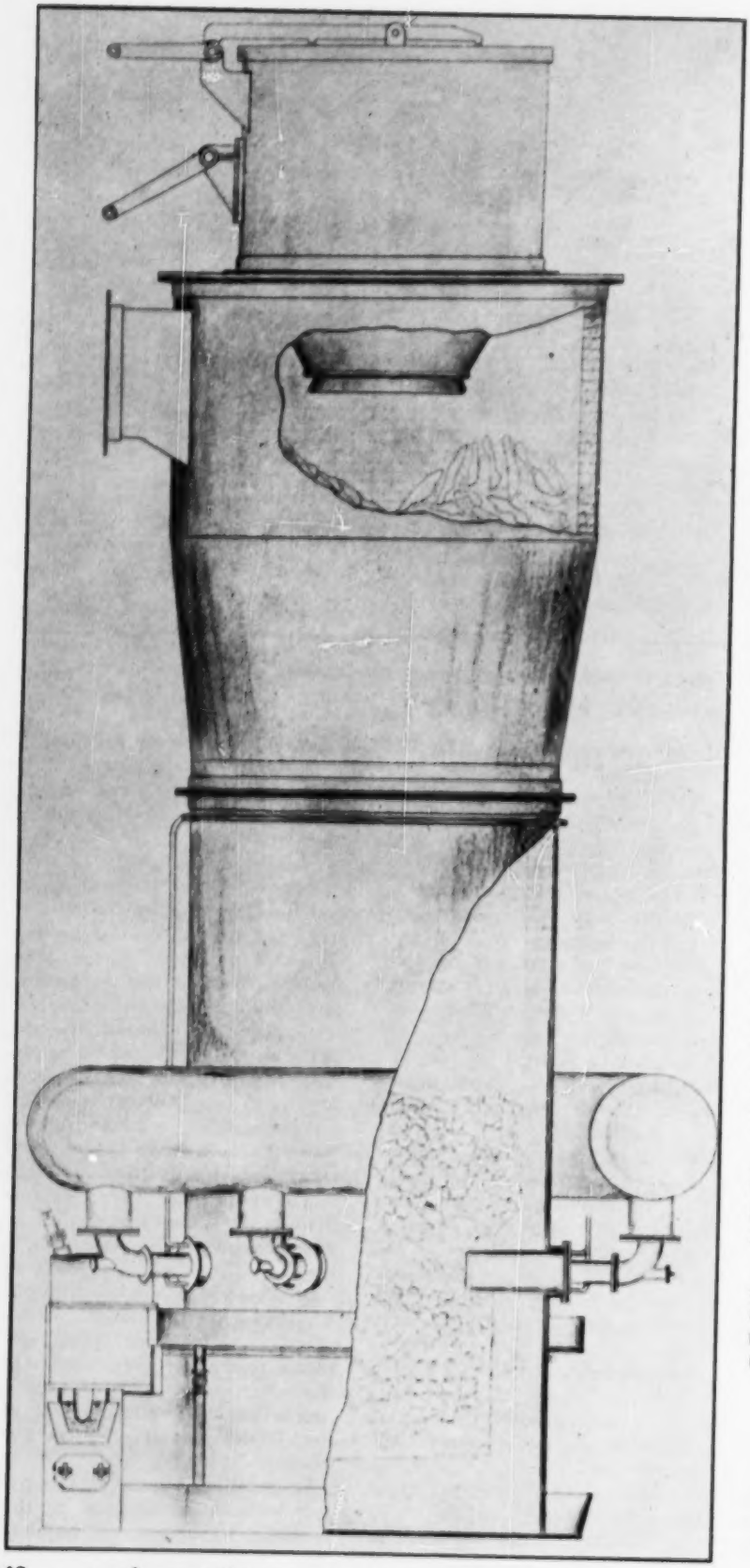
c) Maintaining the slag depth at a constant predetermined level.

d) Continuous tapping.

e) Extended operation unhampered by present refractory limitations.

In order to confine the combustion reaction to a concentrated area and thereby minimize the zone of free oxygen, use of projecting tuyeres is indicated (Fig. 4). Such tuyeres, which generally are made of copper and of necessity are water cooled, permit the introduction of the air at any predetermined distance from the center. Consequently, a much more concentrated combustion (higher reaction temperatures) is accomplished and the area of free oxygen is greatly minimized.

The need for high $CO:CO_2$ ratios in order to promote carbon pick-up and reducing conditions is usually met by increasing the amount of coke. This added cost, however, can be substantially minimized by the adoption of hot blast. Tests have shown that whereas the maximum flame temperature for cold blast is around 3600 F, temperatures of over 4000 F can be reached by preheating the blast to about 1000 F. The resultant increase in reaction rate reduces the amount of coke necessary to achieve the required



reaction temperature.

Ability to adjust the slag to any predetermined composition, whether acid, neural or basic, necessitates the elimination of uncontrollable contaminants, such as normally produced by refractory erosion, metallic oxides, etc. This can best be accomplished by the judicious application of water cooling to the melting zone and preferably also to the well. It will be found that water, properly used, constitutes an excellent refractory and permits the elimination of conventional lining materials in the melting zone which are automatically replaced by a thin layer of slag, coating the inside wall. Consequently, no contamination is derived from the melting zone. As for the well area, a neutral material such as graphite, in conjunction with water cooling, gives excellent results and operational life.

Coupled with the ability to control the composition of the slag must also be the ability to control the volume, temperature, and viscosity, if effective desulphurization and deoxidation are to be accomplished. It is, therefore, obvious that the depth of the well must be adjusted so as to allow adequate time for the required slag/coke and metal/coke reactions. The depth, however, must not be so great as to cause undue heat losses with a resultant lowering of the slag and metal temperatures, nor must the slag level be so close to the tuyeres as to cause reoxidation. The latter condition, aside from its detrimental effect on the reactivity of the slag, frequently leads to excessive foaming.

The slag level and consequently the volume can best be controlled by means of a conventional syphon box, thereby necessitating the use of forehearths.

Aside from the advantages listed above, it becomes obvious that the application of water cooling permits continuous operation over extended periods as refractory prob-

Fig. 7 . . Metallurgical blast cupola is mounted on concrete foundation, has side door instead of drop bottom doors.

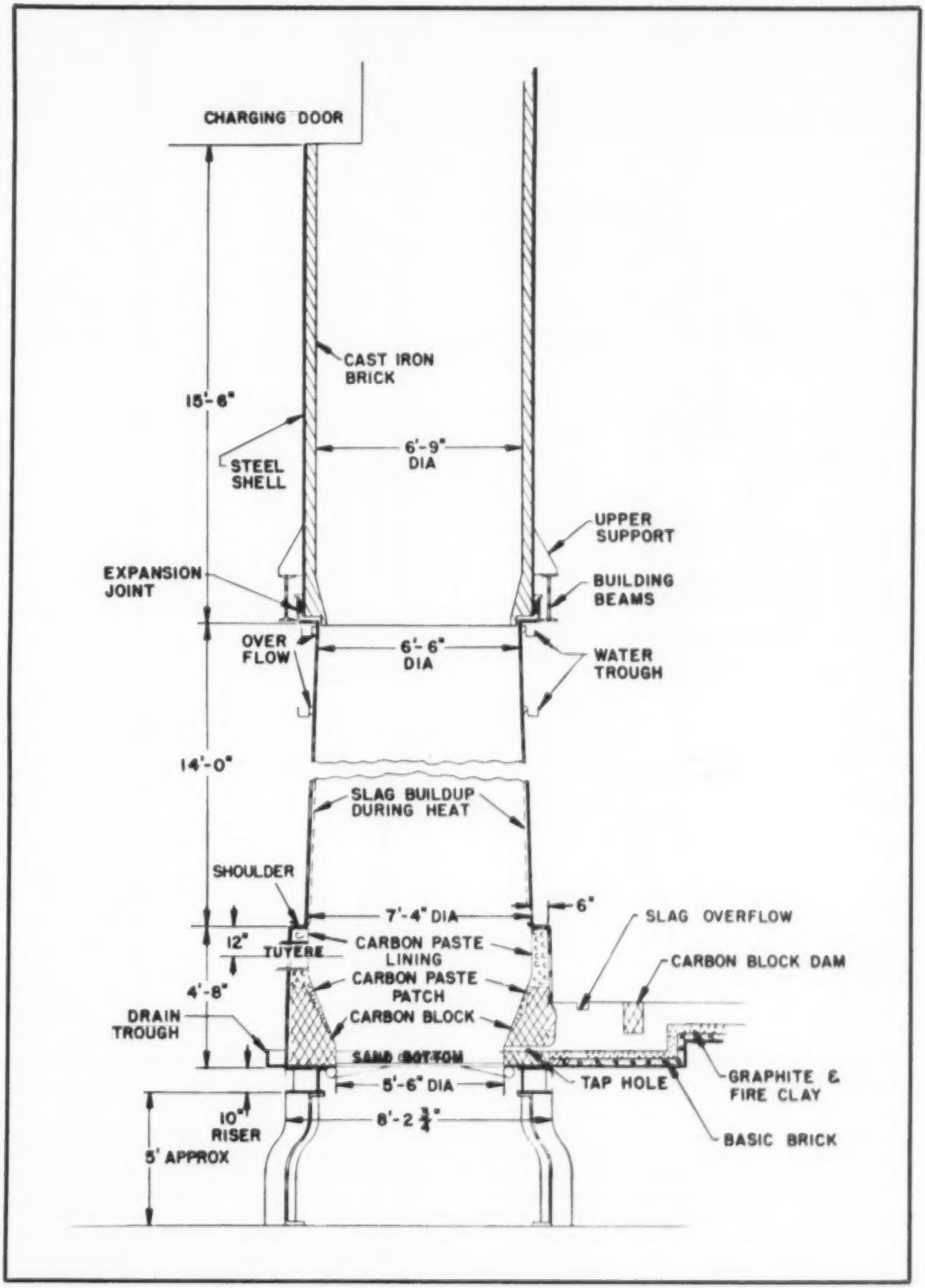


Fig. 8 . . Open top, externally water cooled cold blast cupola has no refractory in combustion or melting zone.

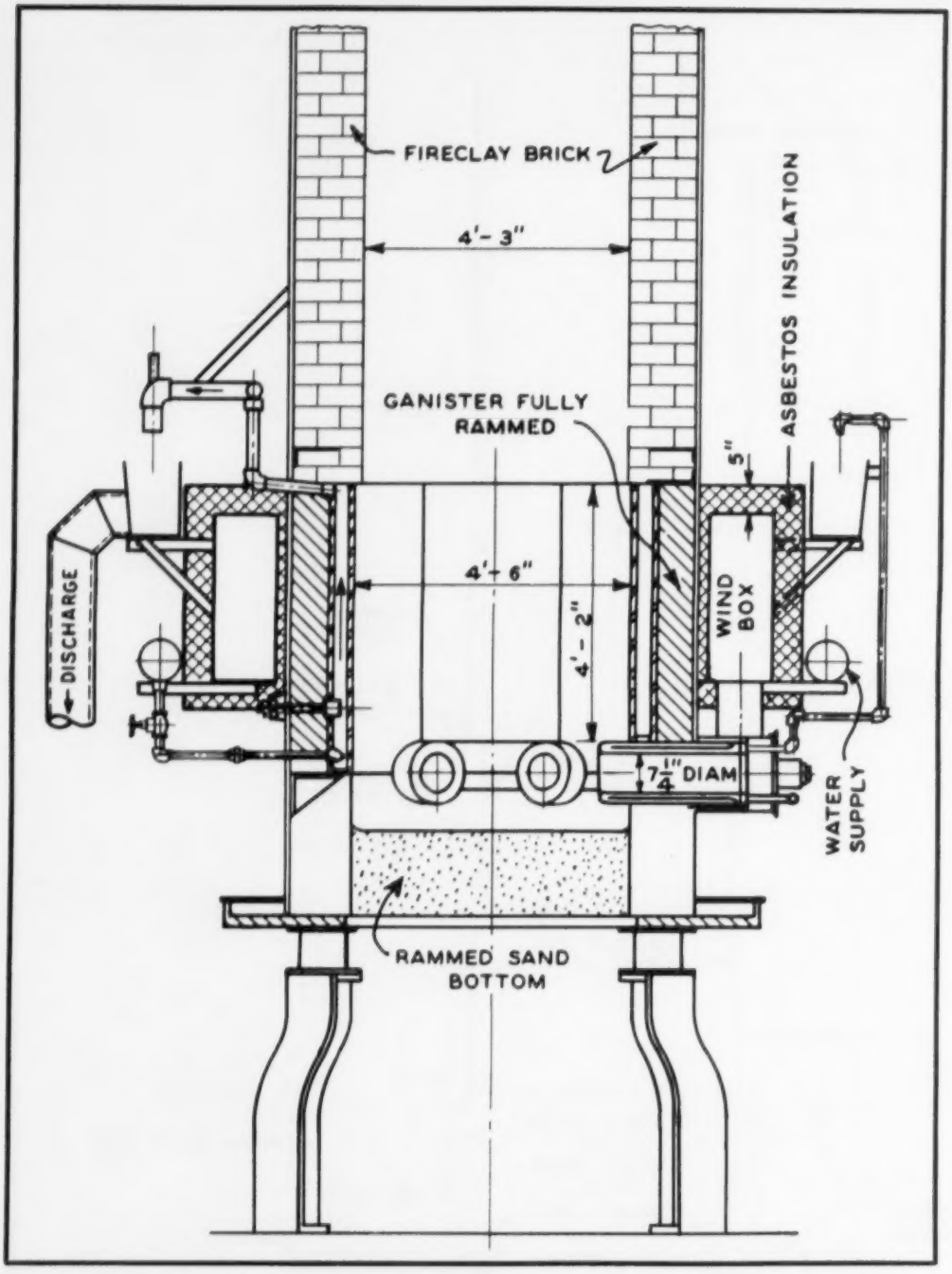


Fig. 9 . . Internal water cooling is as effective as external but is more complex.

lems are largely eliminated.

Considering all factors involved, it may be concluded that the best approach to date is the application of water cooling and that such an installation should preferably consist of a closed top cupola equipped with fully cooled melting zone and well, projecting tuyeres, continuous tapping device, and high temperature hotblast.

It may further be concluded that such a cupola will meet present carbon specifications with high steel charges (up to 100 per cent) with the added advantage of low phosphorous and effective desulphurization. In addition, the economy of operation compares favorably with present practice and therefore does not limit the application to specialty irons but offers advantages in the manufacture of commercial gray iron.

Water-cooled Cupolas

Various types of water-cooled cupolas have been developed in this country and abroad. Although in principle the same, they differ in the method adopted for cooling. This may be accomplished either by internal water jackets or a series of tubes, or by a blanket of water flowing down the outside of the shell. Opinions differ as to the merit of these two systems but it is believed that the external method because of its simplicity presents fewer operating problems. Both types have given excellent results over several years of operation.

■ **Closed Top Externally Water-Cooled Cupola.** The installation shown in Fig. 5, 6, and 7 has been selected to demonstrate an operation incorporating all the features outlined in the above conclusions.

The cupola shell (Fig. 7) is all-welded construction, using heavy gauge rolled plate (1¼ in. thick), mounted on a solid concrete foundation. A side door in the well area replaces conventional drop bottom doors and serves to clean out remaining coke and slag at the end of the melting campaign and also permits entrance for the purpose of inspection and repair.

The top of the cupola is composed of a bell and hopper arrangement, similar to blast furnace construction, except that the upper end is sealed by a hinged lid hydraulically activated by means of a lever arm, instead of the conventional upper bell.

The tuyere arrangement consists of eight projecting water-cooled copper tuyeres connected to a brick lined bustle pipe.

The cupola shell is water-cooled by means of a heavy spray from a perforated pipe encircling the unit which forms a solid blanket flowing down the outside. This water is collected in a trough at the tuyere level. A second perforated pipe located under this trough supplies the water required for cooling the well area.

The upper portion of the cupola stack is lined with conventional brick. The reduction, melting, and combustion zone require no refractories. The practice has, however, been to coat this area with a thin insulating layer of a high carbonaceous or dolomitic material either rammed or sprayed-in prior to starting the campaign. The purpose of this is to arrive at proper reaction temperatures faster and thereby higher initial metal temperature.

The refractory used in the well consists of a high carbonaceous material either monolithic or in the form of carbon blocks.

Continuous metal tapping and slag removal is accomplished by means of a siphon arrangement based on conventional principles. The cooling water from the tuyeres is used to disintegrate the slug.

In the operation of the cupola, the charging is accomplished by means of a skip hoist equipped with a tilting bucket (Fig. 6). As the bucket reaches the charging position, the top lid is automatically opened and the charge is deposited into the hopper. Immediately following this, the lid is closed and the bell lowered, permitting the charge to enter the stack proper.

Want More Details on Special Cupolas?

READ . . .

- **THE CUPOLA AND ITS OPERATION, 2d ed., American Foundrymen's Society, 1954, 300 pp.**
- **Doat, R., and M. A. DeBock, "Metallurgical Blast Cupola," TRANSACTIONS, AFS, v 60, 1952, pp 44-52.**
- **Renshaw, E. S. "Basic Cupola Melting and its Possibilities," TRANSACTIONS AFS, v 59, 1951, pp 20-27.**
- **Levi, W. W., "Melting Iron in a Basic Lined Water Cooled Cupola," TRANSACTIONS, AFS, v 60, 1952, pp 740-755.**

Effluent gases (Fig. 5) leave the cupola through an opening located below the bell and may either be by-passed through a stack to the atmosphere or directed to a dry dust collector of the cyclone type by means of a water-cooled slide valve located in the duct between the stack and the collector. In this latter unit, the coarse particles carried through by the gas are removed, prior to entering a two-stage wet scrubber involving a pre and post conditioning technique, where the major portion of the remaining fines are removed. The clean gas is burned in the combustion chamber of the recuperator and serves to heat the blast air to a temperature of 1000 F. The cupola operates under a slight positive pressure which is regulated by means of a suction blower at the exit end of the scrubber.

A number of installations of this general type (both acid and basic) including some with conventional drop bottom doors rather than the permanent bottom design have been in operation over a period of several years. Usually, the cupolas operate on a basis of five consecutive 16-hour shifts but on several occasions operations covering several weeks have been successfully carried out without necessitating shutdowns for internal repair. At the end of each shift, the cupola is banked for the night by first draining out all slag and metal and then adding a few charges of coke.

The advantages claimed for this type of operation are:

a) Excellent control of reactions permitting the use of low cost raw materials.

b) A wide latitude in the selection of slags, thereby allowing effective desulphurization.

c) Ability to operate with low grade, high sulphur cokes without detrimental effect on the final results.

In addition, the principle of cleaning the gases prior to their use in the recuperative system greatly diminishes maintenance problems.

■ **Open Top Externally Water-Cooled Cupola.** Figure 8 shows a sectional view of an open top, drop bottom door, continously tapping, cold blast cupola. As will be noticed, this cupola is supported on columns in the customary manner. The bottom portion of the stack is formed by a conical structure composed of a lower section (4 ft 8 in. high) containing the well and conventional tuyeres, and an upper stepped-in section (14 ft high) forming the melting zone. The continuation of the stack is a cylindrical shell independently supported and connected with the

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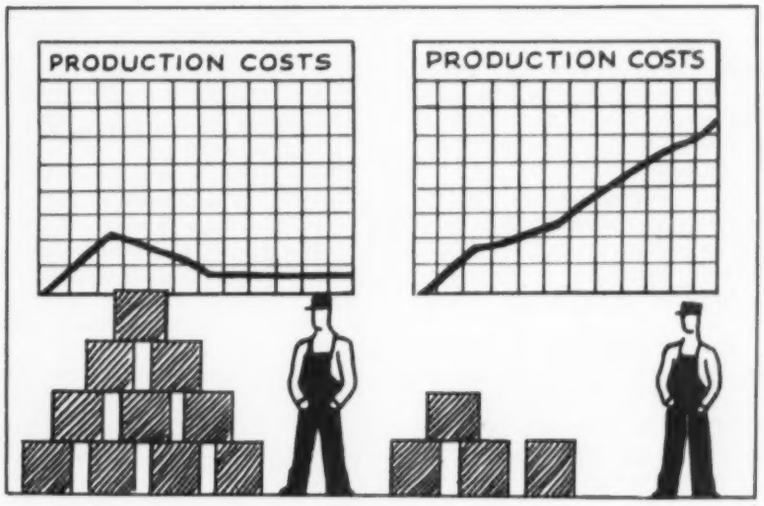


■ Costs are of paramount consideration because knowledge of costs is a requisite to their control. No customer or group of customers will guarantee us that we will recover our costs plus a profit. In order first to obtain and then to keep business we must hold our costs at the lowest possible level; we must have full knowledge of what comprises these costs and through this knowledge we must exercise control over them and keep them from getting out of hand.

No business enterprise can be conducted successfully nor exist for a long period of time on any premise which contemplates no more than the recovery of costs. Consequently, our selling prices must include a margin over these costs which will permit us to pay for the use of the capital involved in our operation. (While a true cost, return on capital is seldom treated as such for accounting purposes.)

Cost accounting gives us knowledge of our costs and from that point we are on our own. In one area of cost accounting in the gray iron jobbing foundry business we have been flagrantly delinquent in acquiring the knowledge which we need. That area concerns the variations in costs inherent in the production of our product in varying quantities.

My company has spent considerable time and effort in the study of this particular problem and we have come to some startling (to us, at least) conclusions:

1. That the lack of differential quantity pricing based on the variations in costs resulting from the variations in quantities produced ranks next to flat-pricing as a danger to the castings supplier.

2. That the only time this method of pricing can be made palatable and acceptable to the customer is when the original quotation is made.

3. That we, in our purchase of chaplets, grinding wheels, etc., meet this matter of quantity discounts and premiums regularly and accept it without reservations or objection.

4. The P. A.'s who buy our castings are accustomed to this method of pricing in all fields other than in their dealings with the foundries.

5. It is a fair method, it is intelligent and we had better get wise to ourselves.

Let us examine a hypothetical situation. The Joseph Q. Doakes Mfg. Co. became the customer of the Sam Smith Foundry Co. in 1951. It ordered castings for its product, the "Slim Jim Noodle Twister", in lots of 1000 pieces. Sam Smith set his prices on the basis of those lots of 1000. But in 1952 the orders fell off to 500 at a time, in 1953 to 250 and in 1954 to 50 pieces per order.

Sam finds himself in a spot. At 1000 pieces for a single run Sam had made a fair margin over costs, at 500 pieces he just about broke even, at 250 pieces he was hurting badly and when the orders came in 50 pieces at a time he produced them with the sickening awareness that the equivalent of many dollar bills accompanied each shipment. His costs to produce the short runs inevitably were far higher per piece than they had been on the quantities on which he had originally based his prices.

Now let's try to look into Sam's mind. First of all he likes Joe and (for obvious reasons, since he is sharing them) he has sympathies for Joe's problems as related to volume. To himself he says, "How in the hell can I go to Joe, who is already taking a beating, and raise his castings prices?" So, usually, he doesn't. He not only bleeds for Joe emotionally but he also bleeds for Joe financially.

On the other hand let's try to look into Joe's mind. Joe buys lots of things other than castings which enter into his product. And the price on almost every single one of these other items is based in part on the quantity which Joe purchases. When the volume of his purchases rises Joe makes savings in the prices he pays. When it falls the individual units cost Joe more. In every case this is true except for the castings Joe buys from Sam because Sam did not set up quantity differentials in his original pricing.

Now to get back to costs. Is there a determinable difference in cost, for instance, in producing castings from one mold off a squeezer matchplate and 10,000 molds from the same matchplate? Yes, there is, and no one knows it better than you. Well, what is the range and variety of difference in cost? With each shop it will vary.

After long discussion, cost-finding, examination of variables, discussion again, etc., these are our first conclusions. Remember we are speaking of costs and believe them at this point to hinge on one full day's production of a molder as the norm. This we classify as 100 per cent or base cost. We then add a certain percentage of total base cost for shorter runs, using steps of ½, ¼, 1/10 and 1/25 day's run and deduct a certain percentage of total base cost for longer runs, using steps of 3, 7 and 12 (or over) day's run.

It is obvious that this approach to cost determination is too new for any of us to claim that we have found the best method of calculating the higher cost of short orders. One thing is certain, however, and that is most of us have been de-

lower portion by means of an expansion joint.

Although the refractory used in the well area is similar to that used in the previous unit, no refractory is used in the combustion or melting zone. The portion of the cupola above the conical section is lined with cast iron blocks.

The cone shaped portion of the shell involving the melting zone and the well is cooled by a water curtain produced by continuously overflowing two water troughs encircling the shell. This water, after completing its function is collected in a drain trough and used to flush the slag.

In the operation, approximately 150 gallons of water per minute is applied to the shell when the cupola is lighted and this is increased to about 260 gallons when melting begins. At that time, the temperature rise of the water is about 90 F. After a short period, a slag coating about one inch thick forms on the inside of the unlined portion of the shell and acts as insulation. The volume of water is then reduced to about 220 gallons per minute with a temperature rise of about 70 F.

This particular installation represents a design which originated in France and has been adopted by an Eastern foundry for the manufacture of centrifugal cast pipe. In the interest of economy, and in order to circumvent certain raw material shortages, it was desirable for this foundry to use the highest possible percentage of ordinary commercially purchased scrap iron. As this type of scrap had always been found to contain an appreciable amount of steel such practice would be restricted, if dependent upon conventional operation, by the carbon and sulphur requirements which called for 3.65/3.75 percent and 0.09 percent maximum, respectively. Although these could possibly have been met by operating a conventional acid lined cupola with high limestone additions or a basic lined cupola, economy of operation dictated the use of a water-cooled cupola.

▪ **Internally Water-Cooled Cupolas.** As already mentioned, internal water cooling can be accomplished either by using built-in water jackets or by means of a series of closely spaced water tubes.

Figure 9 shows a sectional view of a cupola with built-in water jackets. This construction has been used extensively in Europe in connection with acid as well as basic operation. Experience in this country, however, has indicated that external water cooling is equally effective and simplifies the problem of converting a conventional stack to a water cooled cupola. In connection with acid practice, the purpose of such water jackets has been primarily to effect economy by minimizing refractory requirements. One such installation, however, has been in use in an English foundry over a period of several years, involving basic operation.

The installation shown in Fig. 10 incorporates the use of a series of closely spaced water tubes extending up 76 in. from the tuyere level. This type of cooling arrangement has given excellent results over a period of more than a year in daily production of melting iron for centrifugal castings as well as of the low sulphur type desired for the manufacture of nodular cast iron.

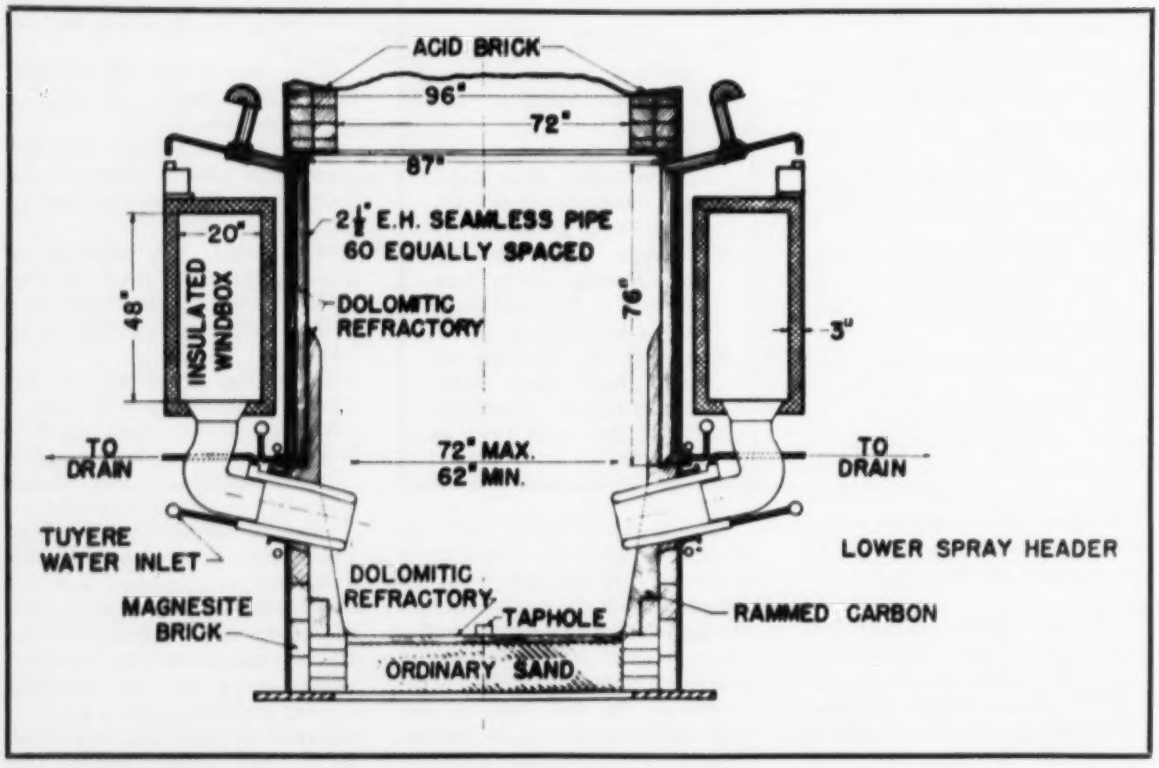


Fig. 10 . . Internal water cooling with series of closely spaced tubes has given good service.

luded in the past when we were so sure our "short-order" prices were covering our costs and providing us with a margin over these costs. The "short-order" prices had what appeared to be a great advantage. It took no thought and little time to apply them; we simply took the weight of the castings involved in the order and obtained our price by finding that figure listed opposite the weight on our chart. Easy? Yes. Accurate? No.

What are the items which must be considered as increasing our costs on the small production orders as compared with those which must be taken to process every order whether it be for one unit or a million. In our company they are as follows:

1. Order entered on production manager's master cards complete with order date, order number, number of units, delivery date required, type of iron specified, pattern number, etc.

2. Price on purchase order checked against price records by billing clerk.

3. Production order issued to foundry along with pertinent information as to delivery requirements, etc.

4. Core production order issued to core room, if cores are required, with appropriate lead time to permit foundry to meet delivery requirements.

5. Shipping instructions issued to shipping clerk complete with full details as to customer's name, address, pattern number, delivery requirements and routing if delivery is to be made by a common carrier.

6. Special instructions to the millroom or to inspection if these are necessary.

Normally we find that the services of nine separate and distinct persons are involved on every order before production even begins. This is time on every order, whether for one unit or a million. Is there additional cost involved on the shorter runs? Of course there is.

Now we come to the actual production of castings for each particular order. In every case the following must take place:

1. The pattern is brought from pattern storage.

2. The pattern is examined to make sure it is in condition to produce good castings.

3. The molder is instructed by his supervisor as to the procedure to be followed in making the molds.

4. The corebox equipment is brought from corebox storage.

5. It is examined to make certain it is in proper condition to produce acceptable cores.

6. The coremaker is instructed by his supervisor as to procedure.

7. The shakeout foreman may or may not be given special instructions as to handling the castings. "Let them cool out in the sand" or "watch out for the tits, they break off easily."

8. In the millroom, instructions are given as to whether the castings in question are to be put through the airless blast, the table blast, milled or simply wire-brushed.

9. Decision must be made as to whether chipping is required; whether grinding shall be done on swing grinders, stand grinders or on the bench with hand grinders.

10. And so on, and on and on.

Is there additional cost in producing one unit as compared with ten? Of ten as compared with 100? Of 100 as compared with 1000? Of 1000 as compared with . . . we all know the answer. What have we done about it?

It is my humble suggestion that we should all do something about it and that it should be done as of now.

Another point should be kept in mind. An order for 10,000 castings which specifies delivery in lots of 1000 pieces is, as far as your costs are concerned, the exact equivalent of ten orders each of which is for 1000 castings.

Nor must it be forgotten that percentagewise the loss from foundry defectives is inordinately large on the short runs. How often, in your own memory, has your shop scrapped two or three or four castings before it got the good one to fill an order for a single unit? Besides the scrap loss, supervisory time and effort are also out of proportion.

Make sure your short runs are priced to cover your costs or you will forever harbor a bleeding wound. And don't forget that it is your corporate life blood that is draining away.

This is one of a series of foundry costs articles running in *Gray Iron News* published by the Gray Iron Founders' Society.

Omaha Site of Corn Belt Casting Clinic

■ A casting clinic for ferrous and non-ferrous foundrymen in Nebraska, Iowa, Missouri, Colorado, and adjoining territory will be held at the Rome Hotel in Omaha on November 14 under the sponsorship of the Corn Belt Chapter of the American Foundrymen's Society with the cooperation of the society's Technical Department.

No registration fee will be required for the all-day meeting. Membership in AFS is not required to attend the sessions, and there is no limit to the number of representatives each foundry may send.

General theme of the clinic will be "Means Toward Better Castings." The clinic will be the second annual meeting held by foundrymen in the Omaha area to hear and discuss the solution of technical problems and new developments in castings production.

Hans J. Heine, AFS technical director will conduct the clinic with the assistance of L. J. Pedicini, foundry supervisor, Process Development Section, General Motors Corp.

Text and reference material for further study of the subjects discussed will be provided by AFS. Subject matter for the clinic is indicated in the following program for the sessions:

MONDAY, NOVEMBER 14

Morning Sessions: *"New Horizons for the Foundry Industry,"* conducted by Hans J. Heine

9:00 to 9:50 am . . *"New Horizons in Foundry Progress."* . . . Vacuum Degassing . . . Core Shooting . . . Effective Use of Materials . . . Shell Molding . . . Improved Properties through Minute Additions.

10:00 to 10:50 am . . *"Principles of Vertical Gating"* . . . Fundamentals of Good Gating Design . . . AFS color-sound motion picture, "Effect of Vertical Gating Design on Casting Quality" . . . Discussion.

11:00 to 12:00 noon . . *"The Carbon Dioxide Process"* . . . Fundamentals of the CO_2 Process for Cores and Molds . . . Motion picture on application . . . Demonstration and Discussion.

12:15 to 1:30 pm . . Noon Recess

Afternoon Sessions: *"Principles of Molding Sand Technology,"* conducted by Hans J. Heine and L. J. Pedicini

1:45 to 2:20 pm . . *"Components of Molding Sands."*

2:30 to 3:10 pm . . *"Properties of Molding Sands."*

3:15 to 3:50 pm . . *"Core Sand Practice."*

4:00 to 5:00 pm. . . Discussion.

Registrations for the clinic should be sent to James Brinn, Secretary-Treasurer, Corn Belt Chapter, American Foundryman's Society, 2636 Sewell St., Lincoln, Neb.

Air Pollution No Hazard

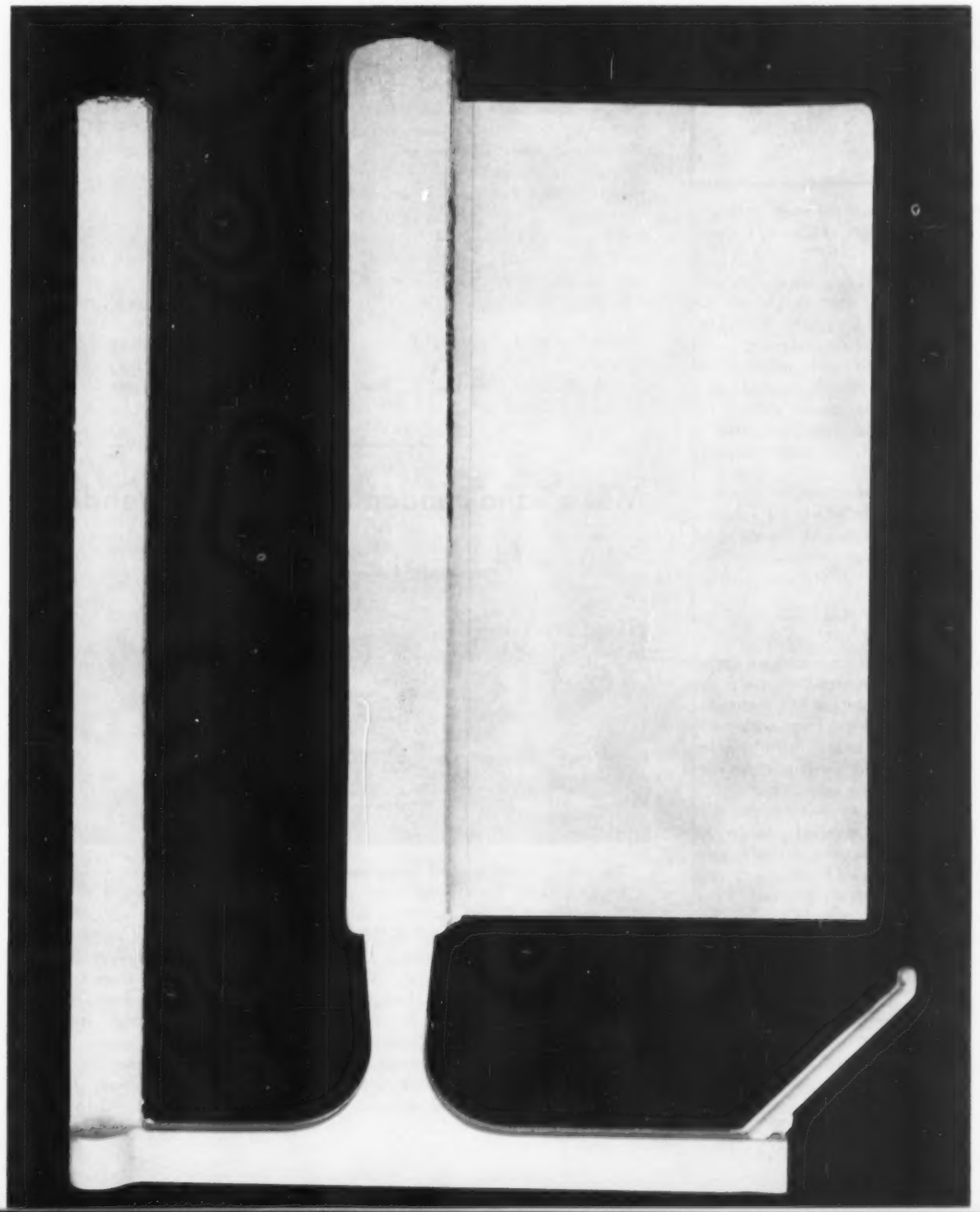
No serious adverse effect on health can be attributed to air pollution according to a study recently released by the California State Department of Health. However, present scientific evidence is insufficient to estimate how near air pollution in California has appoached disaster levels, the report indicates.

The report points out that the air pollution problem is a duty and responsibility for elected local, not state, officials, to solve. While this report is primarily directed to the Los Angeles area, other urban localities in the United States also are being hindered by pollution arising from a variety of man-made sources, including industry, motor vehicle usage and incineration of domestic and other refuse. Natural phenomena, including topography, sunlight, temperature inversions, and lack of wind, alter and concentrate the pollutants and thus increase their effects.

Touching on radioactive pollutants, the report recommends that cities faced with an air pollution problem set up a vigilant monitoring device to constantly appraise the effects of radiation. Anyone interested in this report may obtain copies from the Department of Public Health, State of California, Air Pollution Study Project, 760 Market St., San Francisco 2, Calif.

VERTICAL GATING GETS A NEW LOOK

The latest in gating minimizes aspiration and turbulence and traps dross before it gets to the mold cavity



■ Rectangular sprue, runner, and gate systems are recommended for vertically gating tall, rather thin section castings in permanent molds, shell, and green sand molds. These new recommendations have been developed from research at Battelle Memorial Institute sponsored by Frankford Arsenal, U. S. Army, and the Light Metals Division of the American Foundrymen's Society.

Excellent work on horizontal gating by these investigators has been continued in vertical gating where concern is not so much for distribution of metal over the horizontal section as it is for filling the cavity vertically with a minimum of turbulence and dross generation.

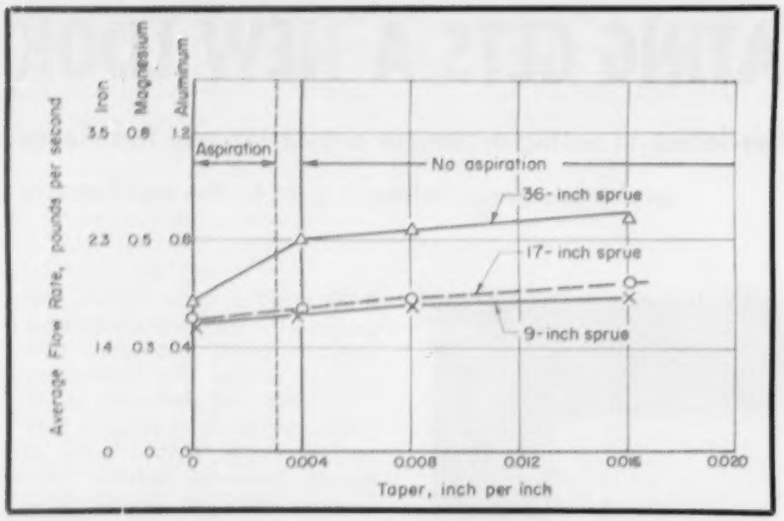
The investigators observed that rectangular geometry provided slightly more restriction to metal flow than a circular shape and thereby reduced metal velocity and turbulence. Other recommendations based on observations include:

- **Taper the sprue** to avoid aspiration of air or mold gases by the falling metal. Put the taper on the sprue thickness and not on the width.

Tests on 9-, 17- and 36-in. high sprues showed that a taper of 0.004 in./in. was sufficient to avoid aspiration when the sprue was attached to a small-section mold. Nine- and 17-in. sprues tapered down to 1/8 x 1 in. at the bottom and attached to the mold have flow rates comparable to those used in pouring aluminum castings in permanent molds (½ lb/sec).

- **Reduce turbulence** at the base of the sprue by adding a simple

Improved gating eliminated dross and shrinkage from shell molded aluminum-7% magnesium casting; note shrinkage in side riser. (picture half size)



Effect of taper on flow through sprue attached to recommended gating system. Cavity has ½ x 6-in. section; sprue bottom is ⅛ x 1 in.

1-in. diameter cylindrical enlargement in line with the runner. Larger cavities are not as effective as the 1-in. enlargment for absorbing some of the kinetic energy of the metal stream and allowing quick washing out of the entrained air.

- **Make the horizontal runner area** at least twice that of the sprue bottom to reduce metal velocity and turbulence. Runners should be 5/16-in. wide and ¾-in. deep for a 1/8 x 1 in. sprue bottom.
- **Extend the runner** past the vertical side riser gate to provide a trap for the first metal which may be drossed by air from preceding portions of the system. For all three sprue heights, an extension of 5 in. appears to be sufficient to prevent backwashing of trapped metal. Essentially clean metal will then enter the gate.
- **Vent the runner extension** at the blind end to insure escape of air and rapid filling by the first metal.
- **Radius corners** of the junction of the runner and vertical gate to minimize aspiration from abrupt change in direction of metal flow.
- **Flare the vertical gate** to the side riser so that the exit area (riser side) is twice that of the entrance (runner side) which should be the same area as the runner. This reduces velocity and turbulence on entering riser.
- **Use a side riser** with web gate extending the full height of the mold cavity to prevent turbulent metal from entering the cavity, to supply metal to the upper levels of the cavity as it is filled, to act as a reservoir of last metal poured for feeding casting shrinkage, and to retain some of the dross that may get this far.

Determine riser dimensions that will prevent shrinkage for each alloy and casting size. A 1½ x 1½-in. riser is much more satisfactory than a 1 x 1 riser in reducing turbulence.

- **Use a web gate** extending the full height of the cavity and of sufficient width to introduce metal quietly and progressively from the bottom to the top of the mold cavity. The large size riser with wide web gate (¼-in.) reduces cascading through the web into the cavity and resulting turbulence.

Flow of liquid leaving the gate of the recommended design of 1:2:4 (sprue bottom, runner, gate exit) is calculated to be 1, 1½, and 2 ft/sec for the 9-, 17-, and 36-in. sprues, respectively. Although increased velocity means increased turbulence early in the pour, 2 ft/sec is not considered damaging.

The latest thought in gating design, however, will not produce good castings mold after mold unless the entire gating system is put on the pattern.

Name National AFS Nominating Committee

Nominating committee to select officers and directors for elections at the 1956 Annual Business Meeting of American Foundrymen's Society was named August 8 at a meeting of the executive committee of the society's board of directors.

Will Meet December 12

Five committee members were named from lists submitted by chapters eligible this year to suggest members. These five, together with the two immediate past presidents, form the nominating committee which will meet December 12 in Chicago to nominate a president, vice-president, and six directors, endeavoring, as prescribed by the AFS by-laws, "to provide equitable and constant regional representation, and . . . representation for the several branches of the castings industry."

Members of the nominating committee are:

Past President Frank J. Dost (1954-55), Sterling Foundry Co., Wellington, Ohio, *chairman*.

Past President Collins L. Carter (1953-54), Albion Malleable Iron Co., Albion, Mich.

W. T. Shute, Steel Foundry Div., Canadian Car & Foundry Co., Montreal, Que. Representing Region 1, Chapter Group D-Eastern Canada Chapter and Steel.

C. D. Schopp, Link-Belt Co., Indianapolis, Ind. Representing Region 2, Chapter Group J-Central Indiana Chapter and Malleable.

W. D. McMillan, International Harvester Co., Chicago. Representing Region 3, Chapter Group K-Chicago Chapter and Gray Iron.

Earl White, M. A. Bell Co., St. Louis. Representing Region 4, Chapter Group N-Corn Belt Chapter and Supplies.

Howard H. Havies, Vivian Diesels Munitions, Ltd., Vancouver, B. C. Representing Region 5, Chapter Group R-British Columbia Chapter and Gray Iron.

Make Sand Fundamentals Understandable

Discussing molding sand fundamentals in a recent meeting of American Foundrymen's Society technical committees, Basic Concepts 8-V and Flowability 8-E, are: (standing left to right) Robert J. Maddison, Whitehead Brothers Co.; Joseph S. Schumacher, Hill & Griffith Co.; and Clifford E. Wenninger, National Engineering Co., chairman 8-V; (seated around the table from left) Victor M. Rowell, Harry W. Dietert Co., chairman 8-E; Louis J. Pedicini, General Motors Corp.; Lennart A. Soderling, International Harvester Co.; Thomas W. Seaton, American Silica Sand Co.; Joseph E. Foster, AFS technical asst.; Burgess P. Wallace, Whitehead Bros.; O. Jay Myers, Archer-Daniels-Midland Co.; AFS national director and Sand Div. chairman; J. B. Caine, consultant; and Richard W. Heine, University of Wisconsin.

Rush for Casting Congress Exhibit Space

■ Firms planning to exhibit at the 60th Annual Castings Congress of the American Foundrymen's Society have already requested one-half of the floor space available in the world's largest convention hall. The congress will be held May 3 to 9, 1956, in Atlantic City, N. J.

William N. Davis, exhibits manager, announced that 93 exhibitors had made requests for exhibit space less than 30 days after the exhibitors' announcements had been mailed. Davis states that the exhibits of new developments in machinery and processes will make the AFS Castings Congress "the most exciting that has ever been held."

The tentative program for the AFS Congress has been announced, and it details present planning for the technical program.

All technical sessions will be held in the meeting rooms of the convention hall, with a maximum of four technical sessions scheduled for any one time. Roundtable luncheon discussions, however, will be scheduled for hotels rather than for the convention hall.

Special events include:

Symposium on Metallography. Leading metallographers will participate in a discussion of the value of metallography to the foundryman. Both ferrous and non-ferrous metallography will be covered, as well as machinability, properties judged by microstructure, and other phases of metallography.

An AFS Research Exhibit will be set up at the Congress in which all divisions and committees sponsoring research will participate.

A Management Dinner will be sponsored by the Safety, Hygiene and Air Pollution Control Committee to feature community relations.

Applications for hotel reservations for the Congress will be sent out early in 1956. MODERN CASTINGS will also publish an application form. The housing bureau of the Atlantic City Convention Bureau will handle hotel assignments.

Tentative Program . . . 60th Castings Congress

American Foundrymen's Society

Atlantic City, May 3-9, 1956

THURSDAY, MAY 3

8:30 am .... Registration Opens

9:00 am .... NFFS Meetings

Exhibits open 9:00 am - 5:30 pm

12:00 noon .... Author Luncheons: Gray Iron, Malleable, Sand

2:30 pm .... Technical Sessions: Gray Iron; Malleable; Sand

7:00 pm .... NFFS Meetings-Dinner

8:00 pm .... Gray Iron Shop Course

FRIDAY, MAY 4

8:00 am .... Author Breakfasts: Brass & Bronze; Gray Iron; Malleable; Pattern; Light Metals; Sand; Plant Eupment

9:00 am .... Technical Sessions: Brass & Bronze; Gray Iron; Malleable; Pattern

Exhibits open 9:00 am - 5:30 pm

12:00 noon .... Round Table Luncheons; Brass & Bronze; Malleable; Gray Iron

2:30 pm .... Technical Sessions: Light Metals; Plant Equipment; Sand

8:00 pm .... Shop Courses: Gray Iron; Brass & Bronze

SATURDAY, MAY 5

"Atlantic Coast Day"

8:00 am .... Author Breakfasts: Education; Industrial Engineering; Light Metals; Sand; Brass & Bronze; Malleable; Refractories

9:00 am .... Technical Sessions: Education; Industrial Engineering; Light Metals; Sand

Exhibits open 9:00 am - 12:00 noon

12:00 noon .... Annual Business Meeting and C. E. Hoyt Lecture

Exhibits open 2:00 - 5:30

3:00 pm .... Technical Sessions: Brass & Bronze; Refractories
Shop Course: Malleable

7:30 pm .... Annual Banquet

SUNDAY, MAY 6

Exhibits closed

8:00 am .... Committee Breakfast Meetings

9:00 am .... Committee Meetings

12:00 noon .... Committee Luncheon Meetings.

Past Presidents' Luncheon

2:30 pm .... Committee Meetings

7:30 pm .... Canadian Dinner

MONDAY, MAY 7

8:00 am .... Author Breakfasts: Steel; Plant Equipment; Sand; Education; Light Metals; Gray Iron; Heat Transfer; Safety, Hygiene, and Air Pollution Control; Metallography Symposium

9:00 am .... Technical Sessions: Plant Equipment, Steel, Sand

Exhibits open 9:00 am - 5:30 pm

12:00 noon .... Round Table Luncheons; Education; Light Metals
Board Luncheon and Meeting

2:30 pm .... Technical Sessions: Heat Transfer; Gray Iron; Light Metals; Safety, Hygiene and Air Pollution Control

7:30 pm .... Alumni Dinner

8:00 pm .... Sand Shop Course
Metallography Symposium

TUESDAY, MAY 8

8:00 am .... Author Breakfasts; Heat Transfer; Industrial Engineering; Pattern; Gray Iron; Safety, Hygiene and Air Pollution Control; Steel Light Metals; Management; Sand; Metallography Symposium

9:00 am .... Technical Sessions: Heat Transfer; Industrial Engineering; Pattern; Gray Iron

Exhibits open 9:00 am - 5:30 pm

12:00 noon .... Round Table Luncheons: Industrial Engineering; Pattern; Safety, Hygiene and Air Pollution Control

2:30 pm .... Technical Sessions: Steel; Safety, Hygiene and Air Pollution Control; Light Metals

7:00 pm .... Management Dinner

8:00 pm .... Sand Shop Course
Metallography Symposium

WEDNESDAY, MAY 9

8:00 am .... Author Breakfasts; Plant Equipment; Steel; Sand

9:00 am .... Technical Sessions: Plant Equipment; Steel; Sand

12:00 noon .... Round Table Luncheon: Steel

Registration closes 3:00 pm

Exhibits close 5:30 pm

LOOKING INTO THE HEART OF A MOLD

V. D. Frechette, *Prof.*
Ceramic Technology
Alfred University

The microscope is a powerful tool for identifying molding materials, analyzing them, and defining their textural characteristics.

The castings industry is seriously in need of methods of describing foundry molds accurately and in detail. The mechanism of metal casting and the mechanism of molding sand deterioration need to be studied carefully.

Professor Frechette's article describes a powerful tool in the investigation of foundry sands and their textural characteristics through the use of the polarizing microscope together with the stereoscopic microscope.

■ The microscope is the most useful single instrument for the definition of a molding sand system. Its areas of usefulness may be summarized as follows:

1. Identification of the constituent minerals, both natural and artificial, through their optical properties and detection of in-process changes in the minerals, as for example through solid solution effects, by changes in their optical properties.

2. Quantitative analysis in terms of the constituent minerals.

3. Description of the textural characteristics of the mold, including particle size distribution, pore shape and volume and contact relationships among the grains.

Mineral Identification

The procedures for identifying minerals with the polarizing microscope have been fully organized under the heading of optical mineralogy and have been treated in many books, of which some of the most useful are those by Winchell,[1] Rogers and Kerr,[2] and Larsen and Berman.[3] The subject is much too large to develop here, but in brief it may be said to depend upon the determination of such optical constants as the index of refraction, the birefringence or double refraction, color, optic character and optic orientation, i.e., the relationship of optical effects to the crystallographic directions in grains as revealed by the presence of crystal faces, or more usually cleavages. The following will indicate the nature of the simpler measurements.

▪ **Index of refraction.** Refractive index measurement with the microscope is best accomplished by mounting the mineral grains in oils of known index of refraction. Calibrated series of suitable oils can be had from several supply houses. The simple tests for comparison are illustrated in Fig. 1. The sharpness of these effects indicates the magnitude of the difference in index between mineral and mounting medium, a fact which is useful in estimating indices when a permanent mount in a standard medium is used, as in work with thin sections.

▪ **Birefringence.** Most minerals have the property of splitting the light into two rays of different refractive indices; the difference between these indices is termed the birefringence of the mineral. The refractive index corresponding to each ray may be measured by rotating the stage until the vibration direction of the ray is brought parallel the polarizer (i.e., north-south).

It is easier and much faster to obtain the birefringence by observing the interference colors under crossed nicols, i.e., with analyzer inserted. The birefringence is related to these interference colors through the retardation by the expression

$$\text{Birefringence} = \frac{\text{Retardation}}{\text{Thickness}}$$

which may be rendered graphically as the Michel-Levy scale shown in Fig. 2. Because of the difficulty of obtaining precise values for the thickness of grains it is difficult to measure birefringence exactly, but it is useful diagnostically nevertheless.

▪ **Optic character.** As noted above, some minerals do not split light

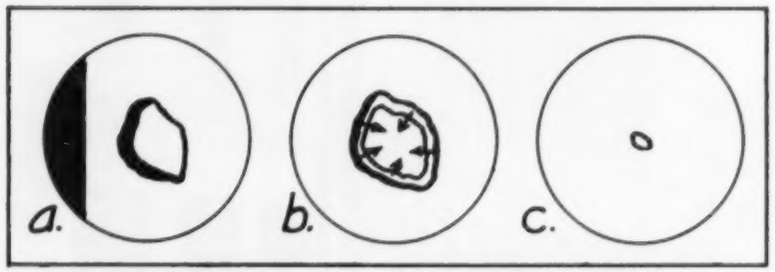


Fig. 1. . Comparison of refraction index of mineral and known index oil.

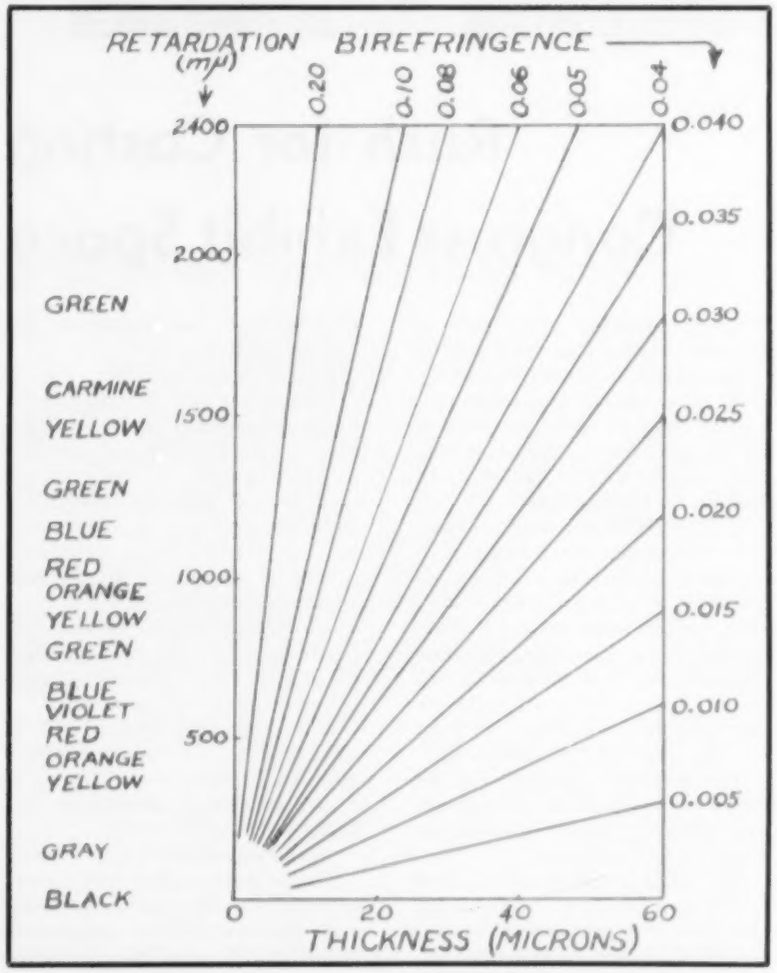


Fig. 2. . Birefringence identification is aided by color analyzer.

into two rays and so exhibit no birefringence. These are termed optically *isotropic* and are extinct (dark) in all positions under crossed nicols. They include the minerals of the cubic system as well as the glasses. Even in these, however, the presence of strain causes birefringence in an amount proportional to the strain present.

Among the birefringent or *anisotropic* minerals two types are distinguished. In one of these belong the minerals of the tetragonal and hexagonal systems which have a single direction (the optic axis) along which only a single ray is transmitted and there is no birefringence. Such minerals are called *uniaxial*. In general they split light into two rays, one (the O-ray) vibrating in a plane which contains the optic axis, which is the c-axis of the mineral. The O-ray has a fixed refractive index. The E-ray which vibrates normal to the O-ray has a variable refractive index which is maximum in positive crystals when it travels normal to the optic axis and is minimum (equal to that of the O-ray) when it travels along the optic axis.

The remaining crystal systems have *biaxial* optic character. They have two directions along which no birefringence occurs, the angle between these being termed the *optic angle*.

■ **Optic orientation.** Observation of the optic orientation, i.e., the relationships between the optic axes and the crystallographic axes of the mineral, as indicated by the presence of crystal faces or of cleavages, constitute a powerful aid in mineral identification. The interference figures obtained by introducing a strong condenser and crossed nicols, together with removal of the microscope eyepiece, constitute an important part of the determination of both optic character and optic orientation.

Other indications are helpful, especially on mineral grains too small to yield useful interference figures. These include the *extinction type* and the *sign of elongation*. To determine the extinction type, the stage is rotated with crossed nicols until the mineral grain darkens (extinguishes) and the relationship between crystal faces or cleavages and the vibration directions in the microscope are noted as shown in Fig. 3.

The sign of elongation (for those crystals or cleavage fragments exhibiting elongation tendencies) is positive if the elongation direction is more nearly parallel the vibration direction of the ray of higher refractive index than that of the other visable ray.

■ **Microsopic data.** Optical descriptions of minerals are available with tables to aid in systematic identification of unknowns.[2-5] Of special interest in connection with foundry sands are the volumes on sedimentary petrography by Milner,[6] and by Krumbein and Pettijohn.[7] Rigby[8] has described some of the high temperature products which may arise in the casting process, and Insley and Frechette[9] have discussed the use of the microscope in connection with foundry practice with notes on the minerals encountered and the techniques employed. Table 1 lists some of those in foundry sands in the order of their greatest refractive indices, N_g, or N_ω, the index of the constant O-ray, in the case of uniaxials. The clay minerals are listed separately in Table 2.

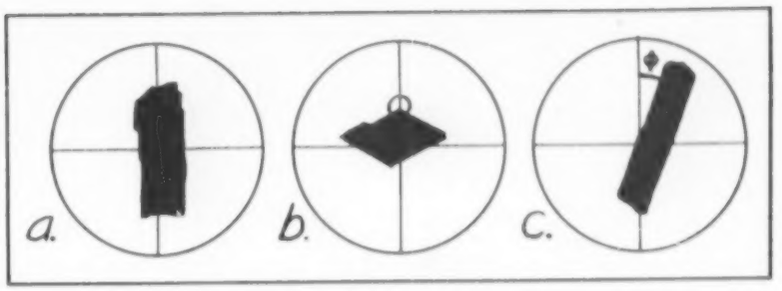


Fig. 3. . Optic axes related to axes of crystal faces or cleavages.

Knowledge of the mineral constitution of molding materials can be most useful in estimating their behavior and anticipating difficulties as well as in suggesting corrective measures, cleaning procedures and so on. In silica sands, contamination by feldspar, mica, hornblende, magnetite, and calcite may

TABLE 1 . . OPTICAL DESCRIPTION OF SOME MINERALS FOUND IN MOLDING SANDS

Mineral	Principal Refractive Index N_g or N_y	Birefringence (N_g-N_p)	Optic Sign, 2V	Grain Resting on Best Cleavage: Figure	Extinction	Elongation	Biref.	Other Diagnostic Features
Cristobalite	1.487	0.003	— Uniax.	No cleavage				Sometimes in skeletal crystals.
Microcline	1.525* 1.530	0.007	— 83°	5° off Acute Bisect.	Inclined	+	0.003	Characterized by plaid-like appearance under crossed nicols owing to two sets of polysynthetic twinnings.
Albite	1.536 1.541	0.010	+ 76°	Plagioclase series of feldspars between albite and anorthite is characterized by clear-cut twinning lamella which in grains lying on perfect 001 cleavage are parallel to visible 010 cleavage; refractive indices on such grains are almost linear function of composition from 1.529 and 1.539 for albite to 1.581 and 1.585 respectively for anorthite.				
Anorthite	1.582 1.588	0.012	— 77°					
Quartz	1.544	0.009	+ Uniax.	No cleavage				Clear irregular, rounded or conchoidal grains which may be stained with Fe_2O_3.
Biotite	1.574 1.638	0.04* 0.06	— ↑10°	Acute Bisect.	Parallel	Sheets ⊥ X	—0	Perfect basal cleavage yields thin flat flakes; usually deep yellow-brown; pleochroic.
Muscovite	1.593 1.611	0.04	— 47-15°	Acute Bisect.	Parallel	Sheets ⊥ X	0.006	Perfect basal cleavage yields thin flat flakes of characteristic appearance having single interference color, surface all in focus.
Tourmaline	1.63 1.69	0.022 0.035	— Uniax.	Cleavages not prominent				Variety of colors with marked pleochroism and maximum absorption parallel 0.
Hornblende	1.633 1.701	0.02 0.03	— 38° to 88°	Off-center	Inclined		—	Pleochroic in greens and browns; perfect 110 cleavages yield elongated to acicular or fibrous grains.
Mullite	1.654	0.012	+ 45-50°		Parallel	+		Elongated (parallel Z) prismatic crystals with parallel extinction positive elongation.
Calcite	1.658	0.172	— Uniax.	Off-center O.A.	Symmetrical	None	0.092	Perfect rhombohedral cleavage; lamellar twinning. Note extreme birefringence.
Dolomite	1.680 1.716	0.180 0.190	— Uniax.	Off-center O.A.	Symmetrical	None	0.08 0.12	Perfect rhombohedral cleavage; polysynthetic twinning common.
Olivine	1.689 1.718	0.037	± 70° to 90°	Acute or obtuse bisect.	Parallel	+	0.012 to 0.019	Imperfect 010, less distinct 100 cleavages.
Periclase	1.736 1.78	None	Isotropic	None	All positions	None	None	Perfect cubic, poor octahedral cleavages. Index increases with iron content.
Garnet	1.741 1.887	None to weak	Isotropic					Irregular grains without cleavage, often grooved or pitted. Colorless, pale reddish, pale to dark brown greenish gray.
Fayalite	1.847 1.886	0.051	— 47°	Acute bisect.	Parallel	—	0.011	Greenish-yellow orthorhombic tabular crystals, elongated parallel Y, which oxidize to reddish brown or black; distinct 010, less distinct 100 cleavages.
Zircon	1.92 1.96	0.04 0.06	+ Uniax.	Flash	Parallel	+	0.04	Poor prismatic cleavage; colorless to pale brown or gray.
Rutile	2.603 2.616	0.286 0.307	+ Uniax.	Flash	Parallel	+	0.286 0.307	(110) cleavage.

*Two figures listed indicate the extremes in range of index or birefringence with change of composition. ↑Equal to or smaller than.

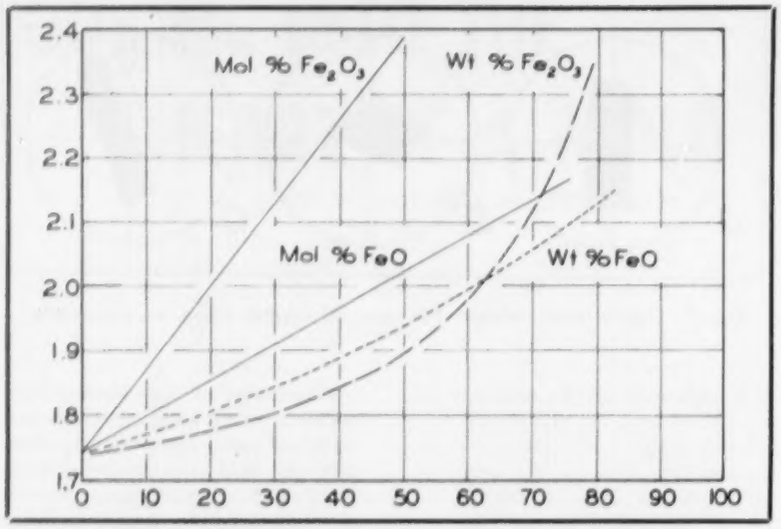


Fig. 4 . . Extent of iron-periclase reaction at mold surface during casting.

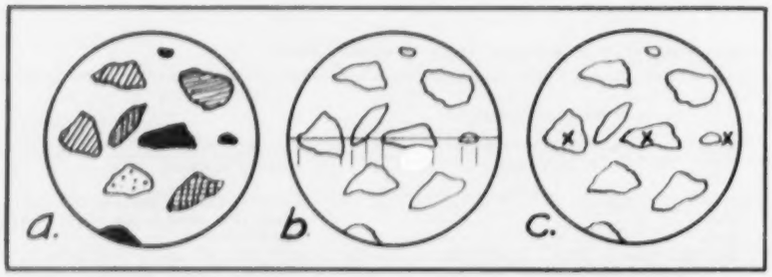


Fig. 5 . . Convenient method for measuring amount of each mineral based on area, is to count the number of times each mineral appears at the cross hairs when the slide is stepped along by a ratchet arrangement.

TABLE 2 . . MICROSCOPIC CHARACTER OF THE CLAY MINERALS*

Clay Mineral	N_z**	N_g-N_x	Optic Sign, 2V	Notes
Kaolinite	1.560 1.570	0.006 0.007	—— 20-50°	(001) Plates often forming curved groups with parallel extinctions. X is about 3° from normal to (001). Optical tests usually conclusive.
Dickite	1.566 1.571	0.006 0.009	+ 52-80°	Monoclinic, platy. XΛC 15-20°; plates standing on edge show extinction angle of 15-20°.
Halloysite ($4H_2O$)	1.526 1.532		Iso. ?	Fine-grained aggregates showing conchoidal fracture. Optical and X-ray data not always conclusive.
Halloysite ($2H_2O$)	1.548 1.556		Iso. ?	
Montmorillonite	1.515*** 1.630	0.025 0.040	—— 0-33°	Very fine-grained, shred-like but clearly crystalline with occasional areas of elongated plates.X (001) almost. Nontronite is pleochroic in yellow-brown-green.
Nontronite	1.600 1.640	0.035 0.040		
Illite	1.57	0.022	—— 0-20°	Resembles mica; sometimes pleochroic. X (001) almost.

* Data from C. S. Ross[10] and from R. E. Grim[11]
** Indices lower if measured with air occluded; two figures listed indicate extremes in range of indices
*** Indices vary somewhat with the exchangeable cation

be encountered. All of these lower the refractoriness of the sand and tend to restrict its use to light service. An abundance of mica is especially undesirable. Not only does it act as a flux but its flat sheets are inclined to align themselves in molding, setting up planes of structural weakness.

The identity of the clay minerals present in natural sands or added in synthetic sands has been shown to be highly significant.[12] The several clay minerals are quite distinct in bonding power, dispersing and coating characteristics, durability and drying behavior. Consequently the microscope and other analytical tools such as differential thermal analysis and x-ray are a necessary adjunct to intelligent compounding and to setting up sand treatment and reclamation practice.

Illite and kaolinite bond clays for example provide molds whose strength is less sensitive to moisture content and to the amount of clay used than does montmorillonite. Halloysite is still less sensitive to moisture content but requires much more water than does montmorillonite. Illite and kaolinite are reluctant to break down into their finest particles and consequently are of the durable type, surviving repeated moding and casting cycles with little decrease in performance.

Such relationships as these are important in controlling the sand so as to achieve sufficient mold strengths without developing excessive strength that would prevent contraction of the casting without damage during cooling and also would make it difficult to strip the mold from the casting later.

■ **Mineral standards.** The microscopist rapidly becomes familiar with the minerals commonly encountered so that he may recognize these at sight without going through formal measurement of properties. To aid in achieving this familiarity a collection of standards is indispensable. Such minerals may be secured from mineralogical supply houses. The collection of clay mineral standards prepared by the American Petroleum Institute and fully described by Kerr et al.[13] is particularly valuable.

Solid solution effects in minerals cause corresponding shifts in the optical properties and so may be inferred from careful measurements with the microscope. The most useful measurement is one of refractive index, in which high precision is possible. Powder mounts are therefore most useful in this work. Color, birefringence, optic angle, and optic orientation all may change continuously with composition in a solid solution series and these have been tabulated for many minerals.[4]

An interesting example in connection with periclase molding sands relates the refractive index of periclase to its content of FeO and Fe_2O_3 (calculated by Walter F. Treffner, General Refractories Co., from the refractive indices of pure MgO, pure $MgO{\cdot}Fe_2O_3$, as reported by Posnjak, and of 66.7 mol percent FeO as reported by Bowen and Schairer — personal communication, 1954).

By means of these data it is possible to trace the extent of the iron-periclase reactions at mold surfaces during casting. As shown in Fig. 4 the relationships are linear when composition is expressed in mol per cent but parabolic when weight per cent is plotted.

It will be observed that ambiguity exists unless it is known whether the iron is in the ferrous or the ferric state; ferrous iron colors periclase green, however, while the presence of the ferric iron causes a yellow to brownish coloration.

Quantitative Analysis in Terms of Minerals

It is frequently useful to know not only the identity of the constituent minerals of new or used molding materials but also their relative amounts. The microscope can give such information by indicating the relative volumes of each of the minerals present and these can be converted to weight per cent values by consideration of the densities of the constituents. Numerous methods have been developed to yield quantitative microscopic analyses[9, 14], but new applications frequently present special problems which require modifications in procedure.

One of the simplest methods involves counting the number of grains of each constituent in a

series of randomly chosen fields until 500 or more have been tallied. This has been successfully applied to the analysis of commercial feldspars but it is limited to those materials in which the particle size distribution is the same for all minerals. Platey or fibrous grains such as those of the micas and clay minerals are particularly troublesome.

Quantitative methods based on the areas of constituent minerals visible in a series of fields in the microscope are less affected by differences in the particle size distribution of the constituents (the error is proportional to grain thickness instead of the cube of the diameter). These may employ actual areal measurement by the use of a planimeter but more conveniently consist of linear traverses, in which the slide is propelled by a series of micrometer screws mounted in tandem.

Each mineral is assigned a particular screw which is used to drive the slide when that particular mineral is observed at the intersection of the crosshairs in the field. At the conclusion of a complete traverse the readings of the micrometers indicate the relative areas of the various minerals and a series of such traverses yields the volume per cent of each mineral present provided the thickness of the grains is the same or has the same distribution.

Another convenient method based on area consists in simply noting the number of times each mineral appears at the intersection of the crosshairs when the specimen slide is stepped along by a ratchet arrangement to permit examination at each of a long series of evenly spaced points (Fig. 5).

The wide distribution of particle sizes in foundry sands makes the above methods uncertain when applied to the materials in powder form. It is suggested that a more reliable procedure would involve preparation of a polished thin section, the microscopic analysis being accomplished with reflected light using either the linear-traverse or the point-counting scheme with the aid of transmitted light, when necessary, for mineral identification.

The procedure involves immersing the specimen material in a resin such as phenol formaldehyde contained in an expendable glass container. A vacuum is applied during the first stages of heating and the thermal curing of the resin is completed at normal pressure. The specimen is sawn, preferably with a diamond saw, to yield a thin slice which is ground flat on a wet cast-iron lap with successively finer grades of SiC beginning with about 150-mesh and finishing with 500-mesh.

The surface may be smoothed with optical emery on a glass plate before cementing with glycol phthalate face down on a glass microscope slide. The process is reported on the reverse side, grinding until the required thinness is reached (not more than 30 microns). The surface is then polished with optical rouge on a cloth flap. Etching to differentiate between the mineral constituents in reflected light, must be suited to the particular problem, the choice of reagents, concentrations, and time of exposure depending on the particular minerals known to be present.

Examination can then proceed using a microscope equipped for both transmitted and vertical illumination. Transmitted light can be switched on to aid in recognizing the constituent minerals in the section. Reflected light is used for quantitative analysis, however, since it insures that only the minerals exposed at the (randomly chosen) surface plane will be measured. Particle size and shape are thereby eliminated as variables influencing the result.

Rough quantitative data may be secured by visual estimation and this is often adequate, especially when conducted by an experienced observer with the aid of reference standards.

Textural Characteristics

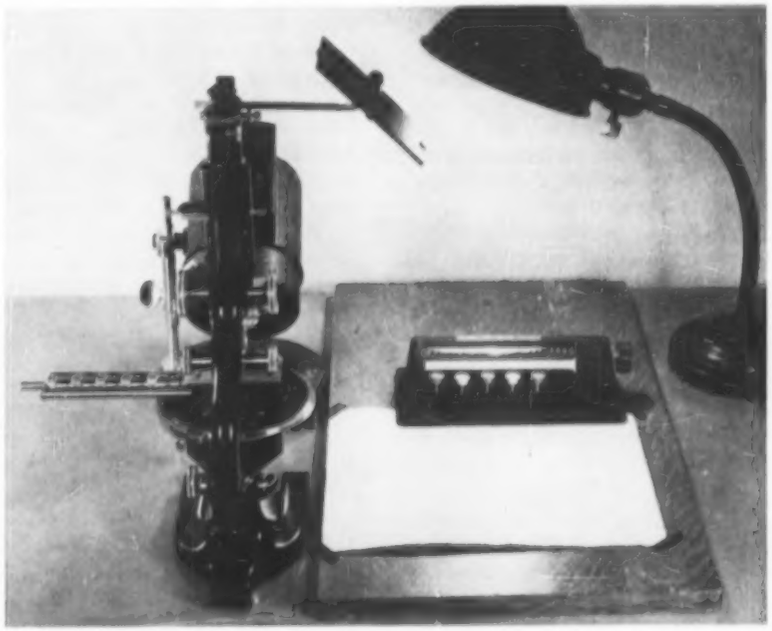
The well-known importance of the textural characteristics of a foundry mold in determining its performance lends special interest to the study of particle size distribution, void shape and size, and the spatial distribution of the constituent minerals.

■ **Specimen preparation.** Particle size and shape studies are best conducted with granular or "powder" mounts, but all other textural studies require preparation of the specimens in sections which preserve the textural characteristics of the mold.

The initial sampling may be done with a core drill or even a cork-borer of large diameter, taking care to avoid disturbing the core during removal and keeping careful track of the site from which the sample is taken. Molds can be sampled in this way and patched with fresh sand[15] avoiding loss of production and providing closer correlation between microscopic data and mold performance.

The sample core can be sliced and impregnated with resin for sectioning as described above. Several variations are possible. If a thin section is required for use with transmitted light only, the polishing step may be omitted and a cover glass cemented to the upper surface of the section. The slide thickness may be adjusted to the purpose at hand from rather thick sections to be used in studying the coarse grains of the mix to very thin ones where the finer constituents are of interest. For study at low power by incident light with the stereoscopic microscope, fine-finishing of the section surfaces may be unnecessary and a cover glass may be omitted.

For studying granular character, packing and homogeneity, it may



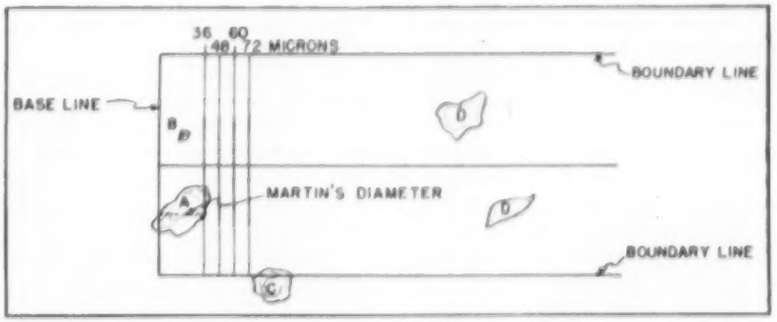


Fig. 6 (above) and 7 (below) . . Precision determination of particle size distribution with microscope and external scale has many advantages over other methods of studying sub-seive fractions of foundry sands.

be valuable to strip a "peel" from surfaces which have been exposed by careful fracture or sawing. The procedure[16] involves flooding the exposed flat surface with amyl acetate and then with pyroxylin. When dry the peel is removed and cemented to a glass microscope slide with Canada balsam, avoiding too high a temperature in mounting.

■ **Particle size distribuion.** Increasing interest in the finer fractions of foundry sands requires methods for dealing with the sub-sieve sizes. While many methods are available, including those based on sedimentation, elutriation, permeability and absorption, the microscopic methods offer some advantages. The particles are actually seen and can be comprehended more easily than the data from non-visual tests. Particle shape can be observed. The distinction between grains made up of a single crystal (or fragment) and those which are agglomerates of several fragments of the same mineral or of different minerals can be drawn.

Unlike the permeability and adsorption methods, the microscope reveals the distribution of particle sizes. Unlike all other methods, it can yield particle "size" data which fit the requirements whatever they may be. Sedimentation methods, on the other hand, provide only an "equivalent settling diameter" which may bear little relationship to foundry sand technology.

A wide variety of microscopic techniques and modifications has been developed[14] and selection must be made carefully to fit the need. The easiest and fastest is simple estimation, and this may be adequate for many purposes in the hands of a trained observer and with the aid of reference standards.

Particle size concepts and recommended methods of microscopic measurement have been reported by Committee E-1 of the American Society for Testing Materials[17] and errors and dispersing techniques have been reviewed by Loveland.[18] A simplified procedure for precision determination of particle size distribution based on the use of an external scale (Fig. 6-7) has advantages in speed of operation.[19]

■ **Particle shape.** Rough classification of grains as rounded, subangular or angular,[19] is easily made by inspection with the microscope but quantitative evaluation of shape is difficult. Attempts along this line list "shape factors" expressing the ratio of maximum-to-minimum particle dimensions, length-to-breadth, etc.[14] Much more work needs to be done in this line and there is probably no substitute at present for actual microscopic observation or photomicrographs.

■ **Void shape and distribution.** While void structure should be amendable to the same type of treatment as particle size, it is not easy to treat quantitatively by microscopic methods. Qualitative impressions concerning the size, continuity, and uniformity of voids, pores, and cracks can be valuable however. The stereoscopic microscope is best suited to such examination on mold surfaces, washes and broken or sawn sections. A wide range of magnifications is advisable to permit inspection of gross structure and of details. Proper illumination is essential and should be standardized so as to facilitate comparison over extended periods.

As in other textural studies, impregnation of the mold prior to sectioning is often necessary to preserve detail. The resin used for impregnation may be colored with a dye such as crystal violet to aid in prompt recognition of the impregnated voids under the microscope.

■ **Spatial distribution of constituents.** Much can be learned by microscopic examination with regard to such features as uniformity of mixing, agglomeration of bond clay, "wetting" of grain surfaces by additives. Again, comparison with file samples is essential in presenting coherent reports, particularly over long periods and between different observers.

Sections properly chosen to show gradients across mold details and normal to the metal-mold surfaces are invaluable in tracing segregation of materials, improper ramming, metal penetration and burn-on effects.[21-25]

The polarizing microscope together with the stereoscopic microscope have already contributed largely to the understanding of foundry mold materials, to their development and to their control in use. Recent trends toward extensive mechanization of sand handling and molding systems and casting lines create increasing demands for reliability and performance of materials. The microscope will undoubtedly be used in developing improved compositions, guarding their specification, and trouble-shooting.

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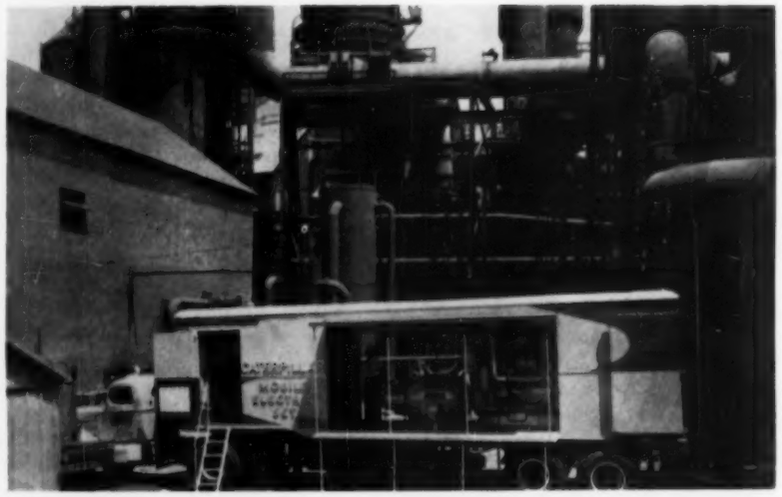
Caterpillar Supplies Emergency Power



While utility servicemen altered electric circuits, emergency power for protection of vital equipment at the Midland, Pa. mill of Crucible Steel Co. of America was supplied recently by a giant Caterpillar Diesel-Electric Set driven to Midland from Peoria, Ill. Mobile plant which is shown above, can be operated by one man and can be hooked up in 15 minutes.

Syracuse Regional Conference Features Pattern Panel

■ Kick-off for the New York State-Canada-Pennsylvania Regional Foundry Conference November 18 and 19 will be a talk and demonstration of the CO_2 process. Onondaga Hotel, Syracuse, N.Y., will be the site of this conference which is sponsored by seven chapters of the American Foundryman's Society.

Sponsoring groups are the Central New York, Eastern Canada, Eastern New York, Rochester,

E. G. White

Western New York, Northwestern Pennsylvania, and Ontario Chapters of AFS. E. G. White, Crouse-Hinds Co., Syracuse is general conference chairman, and James O. Ochsner, Crouse-Hinds Co., is program chairman.

FRIDAY, NOVEMBER 18

10:00 am . . WELCOMING ADDRESSES

10:15 am . . JOINT TECHNICAL SESSION.
"CO_2 Process," John Gotheridge, Foundry Services Co., Ltd. Demonstration at the meeting by Oberdorfer Foundries, Inc.

2:00 pm . . PATTERN PANEL SESSION
"Pattern Requirements for Production Foundries," Kenneth Digney, Oberdorfer Foundries, Inc.
"Coordinating Design and Use of Patterns," Guy A. Pealer, Elmira Foundry.
"Purchasing Patterns," Louis Burns, Carrier Corp.

2:00 pm . . SECTIONAL MEETINGS
"Risering Gray Iron," Charles F. Walton, Technical Director, Gray Iron Founders' Society.
"Gating and Risering Brass and Aluminum Alloys," R. A. Colton and D. L. Lavelle, Federated Metals Div., American Smelting and Refining Co.

3:30 pm . . SECTIONAL MEETINGS
"Digging into Sand Fundamentals,"

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CIRCLE NO. 118, PAGE 79-80

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"Casting Defects," Barney C. Yearle National Malleable & Steel Cas ings Co.

"Dielectric Core Baking"

7:00 pm . . CONFERENCE BANQUE Speaker, William Moss, Cling Su face Co., *"Life in Foreign Lands."*

SATURDAY, NOVEMBER 19

10:00 am . . SECTIONAL MEETINGS

"Modern Gray Iron Cupola Pra tice," T. Burke, Worthingto Corp., Buffalo, N.Y.

"Application of Insulated Risers the Production of Aluminum A loy Castings," W. A. Mader, Obe dorfer Foundries, Inc.

"High Temperature Properties Molding Sands," Victor Rowe Harry W. Dietert Co., Detroit

"Production of Pearlitic Malleab Iron," Gordon B. Mannweile Eastern Malleable Iron Co.

12:00 noon . . LUNCHEON. AFS film *"Study of Fluid Flow of Light Allo through Vertical Gating Systems."*

Announce Michigan Regional Foundry Conference Progam

■ Over 400 foundrymen are e pected for register for the Michiga Regional Conference of the Amer can Foundrymen's Society to b held at Michigan State Universit East Lansing, Michigan, Decembe 1 and 2.

John Schneider, Dearbor Foundry, Ford Motor Co., will ke

J. Van Haver

note the conference with an a dress. *"Morale–The Key t Productivity."* The program speakers, panels, and entertainmen has been arranged under the dire tion of conference general chai man John Van Haver, Sealed Pow

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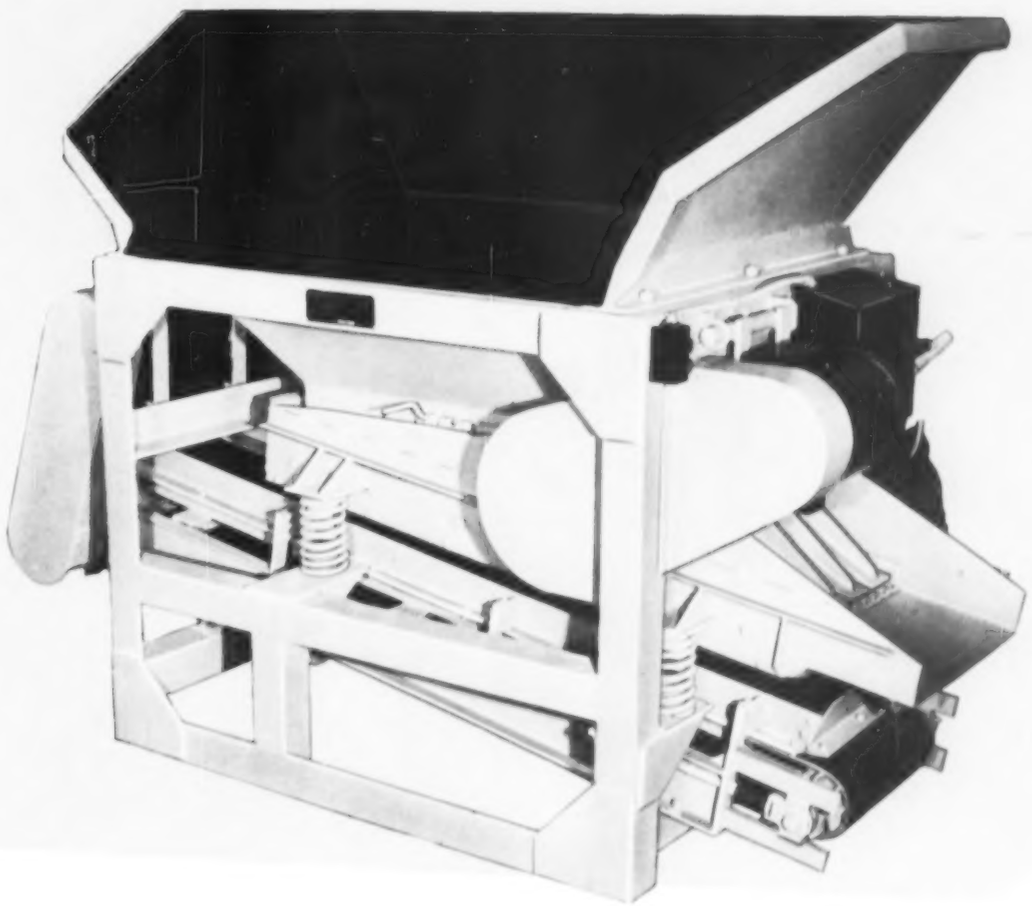
FLOOR MOUNTED... *no pits required for the* NEW "60" PREPARATOR



NEW MACHINE DESIGNED FOR USE WITH ANY FRONT-END LOADER

The new "60" Preparator—designed for use in B&P Speedmullor-Preparator Units—completely conditions up to 40 tons of molding sand per hour, and can be installed without pits of any kind. This one "most needed" feature would make the new "60" Preparator big news, but look at the other new features:

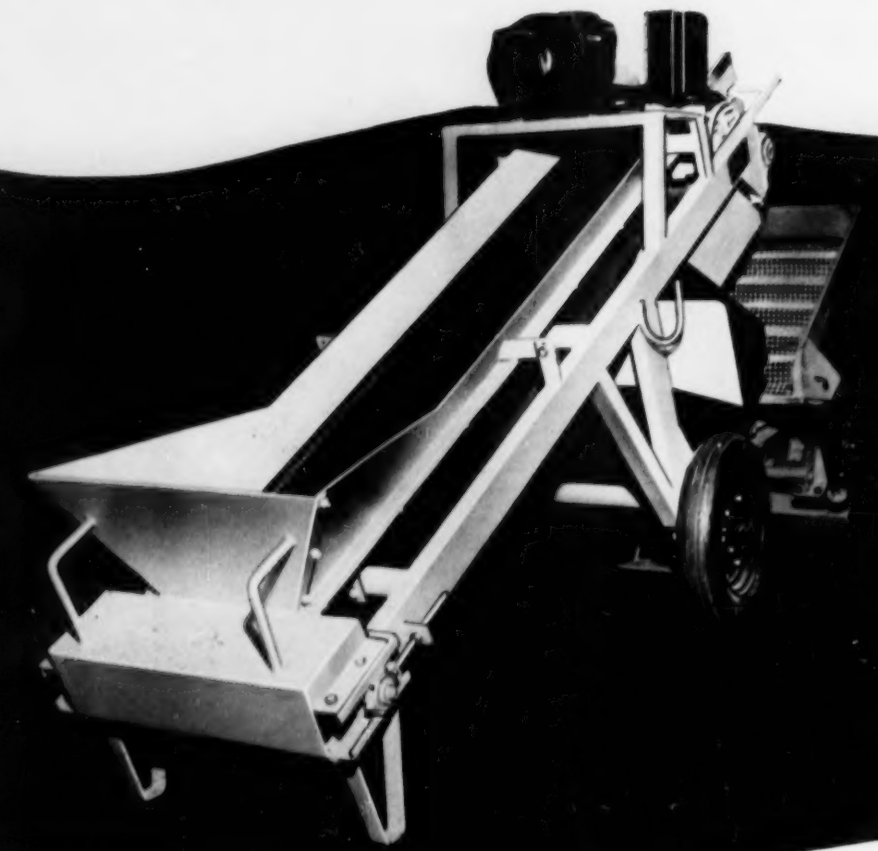
1. 50% greater loading hopper capacity—no waiting to load.
2. Flush-sided construction permits easy loading.
3. Loading height only 4'-2"—low enough for any loader—no ramps required.
4. Permanent magnet separation—no tubes, no rectifiers.
5. High-capacity high-frequency screening—new performance records.
6. New lump breaker—more effective handling of lumps.
7. Also available in a portable model.

For rugged construction and dependable performance, it's the new "60" Preparator. Write now for full data . . . *Beardsley & Piper, Div. Pettibone Mulliken Corp., 2424 N. Cicero Avenue, Chicago 39, Illinois.*

HERE'S THE NEW PORTABLE

MAGNAVEYOR

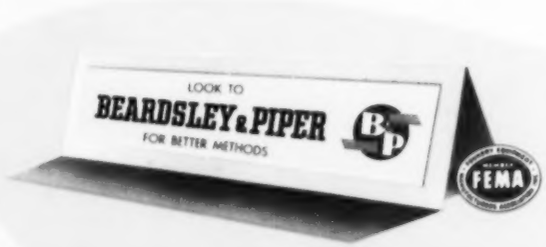
to improve your casting surface



The Magnaveyor is a sturdy new belt loading unit with a dependable permanent magnet separator, built by Beardsley & Piper to meet a definite need for better foundry sand preparation.

The Magnaveyor loads a B&P Screenarator, or other conditioner, at a rate of up to 1500 pounds per minute, and completely separates iron scrap, shot, and wires and nails from the sand being loaded. It is highly portable and may be easily moved by one man from foundry floor to floor. It is easily and quickly placed in operation with a Screenarator, or other device, and appreciably increases the efficiency of the conditioning unit with which it works.

A small knee-high hopper for shovel-loading makes the Magnaveyor particularly convenient for side floor sand preparation. Once you try it your molders will never want to do without it. Write now for information. *Beardsley & Piper, Div. Pettibone Mulliken Corp., 2424 N. Cicero Avenue, Chicago 39, Illinois.*



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Corp., Muskegon, Mich., and D. Strieter, Dow Chemical Co., idland, Mich., program committe chairman.

The conference is sponsored by e Central Michigan, Detroit, Sagiw Valley, Western Michigan apters of AFS, and Michigan ate University and the University Michigan.

HURSDAY, DECEMBER 1

00 am . . REGISTRATION

45 am . . INTRODUCTION AND WELCOMING ADDRESS, Professor L. G. Price, Michigan State University

00 am . . KEYNOTE ADDRESS. *"Morale —The Key to Productivity,"* John Schneider

00 am . . *"The CO_2 Process,"* Hans J. Heine, AFS Technical Director

15 pm . . LUNCHEON. Address by Dr. W. W. Whitehouse.

00 pm . . *"Casting Defect Clinic,"* panel discussion led by Harry E. Gravlin, Claude B. Schneible Co., Detroit.

10 pm . . *"Casting Quality Through Process Control,"* D. E. Krause, Gray Iron Research Institute, Columbus, Ohio.

50 pm . . *"Surface Smoothness and Effect of Process Variables,"* panel discussion led by Professor Charles Pigerfoos, Michigan State University. Panel members: Earl E. Woodliff, Foundry Sand Service & Engineering Co., Detroit; Dr. J. A. Ridderhof, Frederick B. Stevens, Inc., Detroit; C. E. McQuiston, Advance Foundry Co., Dayton, Ohio; Dr. D. C. Williams, Ohio State University, Columbus, Ohio.

30 pm . . BANQUET. Address by Dr. O. B. Varner, Michigan State University. Harry E. Gravlin, master of ceremonies, with professional entertainers.

IDAY, DECEMBER 2

30 am . . *"Blowing Shell Molds and Cores,"* Gerald A. Conger, C. & S. Products Co., Highland Park, Mich.

15 am . . *"Automatic Core Blowing,"* C. W. Hockman and C. W. Law, Cadillac Motor Car Div., GMC, Detroit

30 am . . *"Diaphragm Molding,"* Thomas E. Barlow, Eastern Clay Products Dept., International Minerals & Chemical Corp.

15 am . . *"Intermediate Strength Iron,"* Professor Richard Schneidewind, University of Michigan

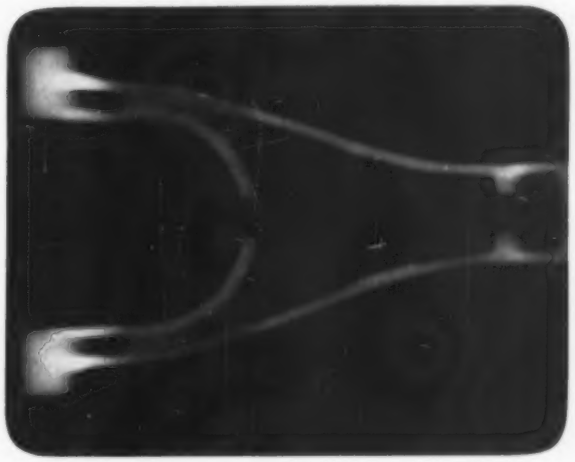
15 pm . . LUNCHEON. Address by Hans J. Heine

00 pm . . STUDENT AWARD PAPER

15 pm . . SELECTED FOUNDRY MOVIES

Shrink steals strength — and profits

— RADIOGRAPHY points the way to avoid it



THIS steel fork lever was designed to take a specific load. Would it hold up? Not if shrinkage had robbed its strength.

But here is where radiography came in with double-barreled effect. First the radiographs which were made showed the foundryman that internal shrinkage was present. Then the radiographs disclosed a recurring pattern of these defects, thus suggesting a change in molding which greatly reduced the difficulty.

This is typical of the ways radiography helps the foundryman make sure only satisfactory work is delivered and so builds a reputation for high-quality castings.

If you'd like to know how it can improve your own operations, talk it over with your x-ray dealer. Or, if you like, write us for a free copy of "Radiography as a Foundry Tool."

EASTMAN KODAK COMPANY, X-RAY DIVISION, ROCHESTER 4, N. Y.

Radiography

— another important example of Photography at Work

Kodak

Welcoming foundrymen to the campus is Dean Curtis L. Wilson, University School of Mines & Metallurgy, after introduction by Webb L. Kammerer, Midvale Mining & Mfg. Co., Missouri Valley Regional chairman.

Missouri Regional Talks Broaden Foundry Horizon

HERBERT F. SCOBIE / *Editor*

■ Practical ideas and down-to-earth know how were exchanged September 29 and 30 at the Missouri Valley Regional Foundry Conference as foundrymen followed the conference theme in a two-day interchange of ideas. Sponsored by the St. Louis, Mo-Kan, Tri-State and Missouri School of Mines Chapters of the American Foundrymen's Society in cooperation with the University of Missouri School of Mines & Metallurgy, it was the first foundry technical conference staged in the area.

Conference activities were set up under the chairmanship of Webb L. Kammerer, Midvale Mining & Mfg. Co., St. Louis; Dean Curtis L. Wilson, School of Mines & Metallurgy, was honorary chairman.

Shell cores, gray iron and nonferrous quality control, steel casting design, gating and risering of nonferrous castings, mechanization of small foundries, heat treatment of gray iron, and advantages of steel castings over forgings were among the topics covered in the technical sessions.

Keynote speaker was AFS Technical Director Hans J. Heine who spoke on *"New Horizons in Foundry Progress."* Session chairman was J. T. Westwood, Jr., Blue Valley Foundry Co., Kansas City, Mo.; secretary was Dr. Daniel S. Eppelsheimer, Missouri School of Mines & Metallurgy. Industrial growth can be correlated with research activity, Mr. Heine pointed out, citing the increase in the past 25 years from 0.25 per cent to 1.25 per cent of the gross national product spent on research.

Heine mentioned new developments such as vacuum melting and degassing, pressure molding, shell molding, the CO_2 process, and core "shooting" as indicative of ideas that are broadening foundry production methods. Other advances are being made in personnel management, he indicated, and in techniques of gating and risering, use of minute additions of elements, and in steel casting design for aircraft use.

The country is not graduating enough engineers, Dean Wilson said at the first day's luncheon. He called on industry to help see that schools develop more engineers for the nearly doubled production predicted for the next 25 years.

Speaking as president of the Foundry Educational Foundation, E. C. Hoenicke, Eaton Mfg. Co., Detroit, gave as industry's responsibilities to education: cooperation along the lines of the FEF program; establishment of industrial environment that speeds transition from engineering graduate to foundry engineer; maintenance of proper climate for maximum development of men. At the same time he noted that the individual engineering graduate is responsible for developing himself to the utmost of his ability.

FEF Executive Director E. J. Walsh cited the growing castings market and warned that the castings industry can lose its fair share by failing to take advantage of advances in foundry technology and in better trained personnel. A. L. Hunt, National Bearing Div., American Brake Shoe Co., St. Louis, presided at the luncheon.

"Can Shell Cores Help You?" was discussed by William J. White, Shallway Corp., Connellsville, Pa. J. L. Boles, Green Foundry Co., presided at the session and John Redman, Redman Pattern Works, Kansas City, Mo., was secretary.

Mr. White described a number of castings which had benefited through the use of shell cores. He suggested foundrymen ask these questions in deciding whether a job is adaptable to shell cores: Can I save metal? Machining? Can I get a sounder casting? Would increased venting be valuable? Could wires and rods be eliminated? Is there a shakeout problem with other cores? How about hot cracks? More core production in the same area?

White advised making a good comparison of costs in considering switching to shell cores.

Following the shell core session, three simultaneous sessions were held for gray iron, steel, and nonferrous foundrymen. Gray iron foundrymen heard Charles F. Walton, technical director, Gray Iron Founders' Society, speak on *"Practical Approach to Quality Control in the Gray Iron Foundry."* Nor-

continued on page 73

Joint responsibilities of industry and educational institutions were brought out at conference luncheon.

Calculating Casting Weights

■ Calculating Casting Weights, continued from October (page 71-72), has been developed from the American Foundrymen's Society PATTERNMAKER'S MANUAL and other sources on mensuration.

This concluding section includes formulas for calculating the volumes of solids with flat surfaces and those with curved surfaces. Volumes are then multiplied by the appropriate factor from the Weight Per Cubic Inch table to arrive at the weight of the figure in cast metal.

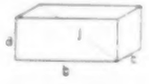
Simplest method covered last month was to multiply the weight of the finished pattern by the appropriate pattern to cast metal conversion factor.

Nomenclature

a to d	lengths of sides
α, β, γ	angles
A	area (total)
A_L	area of lateral or convex surface
b	(subscript) pertains to base
C	lengths of chords
D, d	diameters (major & minor)
e, f	lengths of diagonals of planes
h	height of altitude perpendicular to reference base
h_g	vertical height between centers of gravity of two areas of solid
j	length of diagonal of solid
L	lateral length or slant height
m	(subscript) pertains to midsection
n	number of sides
p	perimeter or circumference
R, r	radii (major & minor)
r	(subscript) pertains to right sections
s	½ perimeter
t	(subscript) pertains to top
V	volume

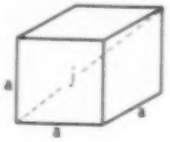
Rectangular Parallelopiped

$j = \sqrt{a^2 + b^2 + c^2}$
$A = 2(ab + bc + ca)$
$V = abc$



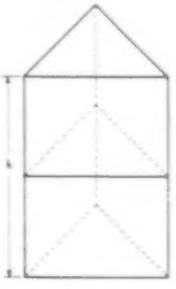
Cube or Hexahedron

$j = a\sqrt{3}$
$A = 6a^2$
$V = a^3$



General and Right Regular Prisms

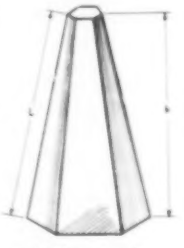
$A_L = p_r L$
$V = A_r L$



$A_L = p_b h$
$V = A_b h$

Right Regular Pyramid and Frustrum

$A_L = \frac{1}{2} p_b L$
$A = A_b + A_L$
$V = 1/3 a_b h$
(for general pyramid also)

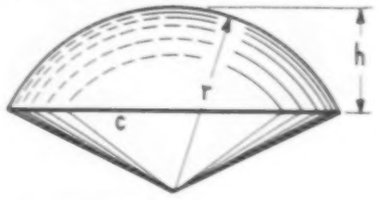


$A_L = \frac{1}{2} L(p_b + p_t)$
$A = A_L + A_b + A_t$
$V = 1/3\ h(A_b + A_t + \sqrt{A_b A_t})$
$= 1/6\ h(A_b + A_t + 4A_m)$
(applies also to frustrum of general pyramid with parallel ends)

Sphere

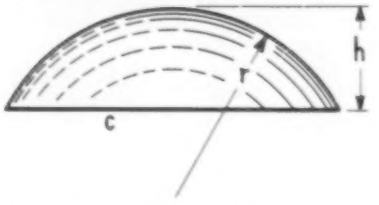
$A = 4\pi r^2$
$= \pi d^2$
$V = 4/3\pi r^3$
$= 1/6\pi d^3$

Spherical Sector



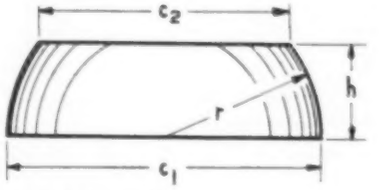
$A = \frac{1}{2}\pi r(4h + c)$
$V = 2/3\pi r^2 h = 1/6\pi d^2 h$

Spherical Segment



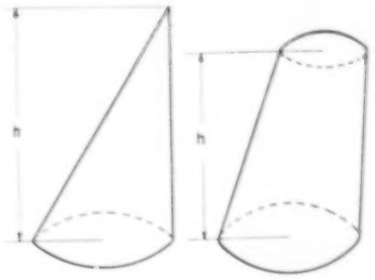
$A_t = 2\pi rh = \pi dh = \frac{1}{4}\pi(c^2 + 4h^2)$
$A = \frac{1}{4}\pi(c^2 + 8rh)$
$V = 1/3\pi h^2(3r - h) = 1/24\pi h(3c^2 + 4h^2)$

Spherical Zone



$A_L = 2\pi rh = \pi dh$
$A = \frac{1}{4}\pi(8rh + c_1^2 + c_2^2)$
$V = 1/24\pi h(3c_1^2 + 3c_2^2 + 4h^2)$

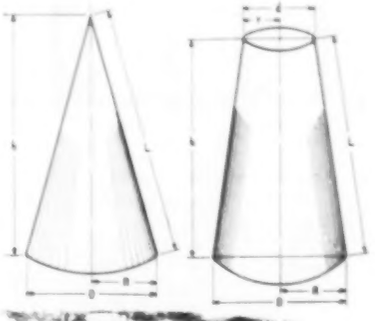
General Cone and Frustrum



$V = 1/3 A_b h$

(parallel ends)
$V = 1/3h(A_t + A_b + \sqrt{A_t A_b})$
$= 1/6h(A_t + A_b + A_m)$

Right Regular Cone and Frustrum



$A_L = \frac{1}{2} p_b L$
$A = A_L + A_b$
$V = 1/3 A_b h$
circular cone:
$A_L = \pi r\sqrt{r^2 + h^2}$
$V = 1/3\pi r^2 h$
$= 1/12\pi d^2 h$

$A_L = \frac{1}{2} L(p_b + p_t)$
$V = 1/3h(A_t + A_b + \sqrt{A_t A_b})$
circular cone:
$A_L = \frac{1}{2}\pi L(D + d)$
$= \pi(R + r)\sqrt{h^2 + (R - r)^2}$
$V = 1/3\pi h(R^2 + Rr + r^2)$
$= 1/12\pi h(D^2 + Dd + d^2)$

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CIRCLE NO. 125, PAGE 79-80

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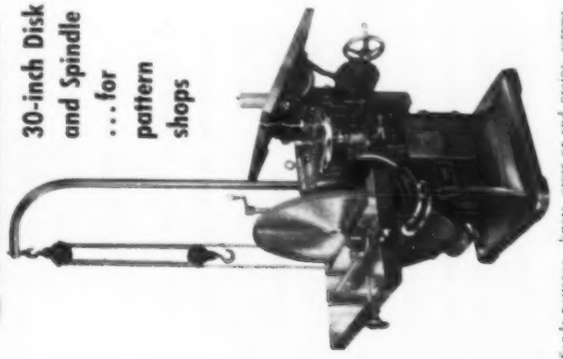
30-inch Disk and Spindle ... for pattern shops

Sands patterns, knots, cross or end grains, screws, nails, etc. Both tables tilt 45°. Disk table adjustable vertically. Takes spindles 2", 3", 4" diameter, 9" long. Duplicating spindle circle sanding attachments. Also made as double disk and double spindle sander. Ask for folder No. 34.
OLIVER MACHINERY COMPANY
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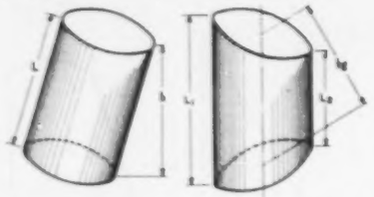
foundry facts

Calculating Casting Weights

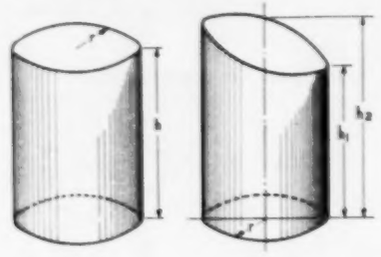
General Cylinder and Frustrum
(any cross section)



$A_1 = p_1 h = p_1 L$
$A = A_1 + 2A_b$
$V = A_b h = A_1 L$

$V = \frac{1}{2} A_1 (L_1 + L_2)$
$= A_b h_2$

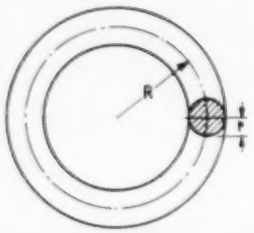
Right Regular Cylinder and Frustrum



$A_1 = 2\pi rh$
$= \pi dh$
$A = 2\pi r(r + h)$
$V = \pi r^2 h$
$= \frac{1}{4}\pi d^2 h$

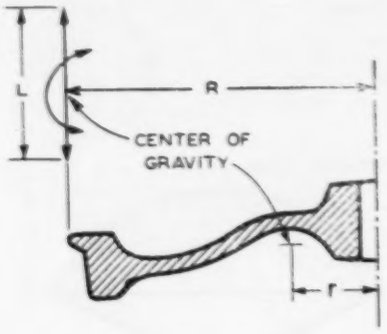
$A_L = \pi r(h_1 + h_2)$
$A_t = \pi r\sqrt{r^2 + \frac{1}{2}(h_1 - h_2}$
$A_b = \pi r^2$
$A = A_L + A_t + A_b$
$V = \frac{1}{2}\pi r^2(h_1 + h_2)$

Ring of Circular Section
or Torus



$A = 4\pi^2 Rr$
$= \pi^2 Dd$
$V = 2\pi^2 Rr^2$
$= \frac{1}{4}\pi^2 Dd^2$

Surface and Solid of Revolution



When a plane curve or straight line revolves around an axis in the same plane, a surface of revolution is formed. A solid of revolution results from rotating an area around an axis in its plane.
L = length of curve
r = center of gravity to axis
α = angle of revolution
A = area of revolving plane
Length of arc described by center of gravity: $q = 2\pi r \frac{\alpha}{360}$

Surface of revolution $= 2\pi rL \frac{\alpha}{360}$

Volume of solid $= 2\pi rA \frac{360}{\alpha}$

Weight Per Cubic Inch

	lb/in.³		lb/in.³
Cast Steel	0.286	"G" or "M" Bronze	.315
Cast Iron	0.260	Aluminum	0.091
Brass	0.296	Tin	0.265
Copper	0.310	Lead	0.40
Zinc	0.260	Plaster of Paris	0.0894

Numerical values of:

$1/12\pi = 0.2618$	$\pi = 3.1416$
$1/6\pi = 0.5236$	$1/\pi = 0.3183$
$\frac{1}{4}\pi = 0.7854$	$4/3\pi = 4.1888$
$1/3\pi = 1.0472$	$2\pi = 6.2832$
$\frac{1}{2}\pi = 1.5708$	$\pi^2 = 9.8696$
$2/3\pi = 2.0944$	$4\pi = 12.5664$
$\sqrt{2} = 1.414$	$\sqrt{3} = 1.7320$

but don't price by the pound

■ The trend toward price-per-piece is largely due to the great improvement in costing practice among foundrymen. The psychology of improved cost methods has led the foundryman to consider the making of castings as a manufacturing process in which he is dealing with individual jobs, rather than with a bulk commodity.

The practice of pricing per pound built up in buyers' minds the idea that castings are worth about so many cents per pound, which implies that all castings are in the same class costwise and are all worth about the same price per pound. Thus they reason, any price per pound which is above the average is an unjustifiably high price and should be questioned.

The idea to price per pound originated primarily from two conditions that were widely prevalent in the early years of the foundry industry:

1. Under the practice of quoting flat prices per pound for a customer's entire requirements, buyers obtained expensive castings for the same price per pound as cheap castings. The foundryman figured that his losses on expensive castings were made up by profits on simple, uncomplicated castings. Under such conditions it was inevitable that the buyer acquired a fixed idea that all castings were worth about the same price.

2. The second factor was the extremely low level of cost practice among foundrymen: a level so low that few had any idea of the cost of the more expensive jobs. In most cases costs were actually calculated on an average cost-per-ton basis.

This attitude is unreasonable because the only test of a fair price is whether or not it is based on actual cost plus a fair profit. In many cases the cost per pound of a light, complicated casting is two to three times the average cost per pound.

Another reason for preferring a piece price policy is that it tends to put castings on the same plane as other manufactured products. Bulk products which are sold by the pound or ton, like sand, cement, pig iron, scrap, etc., seem to have in men's minds a somewhat lower status than products which require skillful fabrication such as machining, tool making, patternmaking, or special machines.

Actually, there is nothing that requires a higher degree of skill, experience, and "know-how" than a complicated casting. Castings are definitely not a bulk commodity!

Piece-pricing is advantageous to buyers as well as sellers:

1. It simplifies the work of the buyer's Cost Department in figuring the cost of his product.

2. Instead of weighing and counting incoming castings the Receiving Department merely counts them. On small lots of heavy castings, the time saved is considerable.

3. The buyer knows exactly what any casting is going to cost him. On a pound basis, variations in weight involve variations in cost.

4. The buyer often receives castings closer to pattern due to more careful molding in a piece-conscious foundry. Unnecessary weight and thickness increase machining costs.

5. The buyer's costing procedures are improved, especially if he makes both large and small machines he would be inaccurate to base casting costs on weight.—J. L. Carter in *Gray Iron News*.

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Standard Metal Directory . . 904 pp. 14th ed. Bardeen Press, Inc., 425 W. 25th St., New York 1, N.Y. 1954. $15.00.

More than 10,000 reports on iron and steel plants, ferrous and non-ferrous foundries, rolling mills, and non-ferrous smelters, listed geographically and alphabetically.

Reports list company name, capitalization, and equipment; products made and primary and secondary raw materials used; and company officials, purchasing agent, and sales manager.

In addition to many special lists of distributors, importers, manufacturers, etc., the new edition has a list of distributors of non-ferrous products throughout the U.S. and Canada and a list of smelters and refiners of non-ferrous metals throughout Europe.

The Practical Engineer Pocket Book . . N. P. W. Moore (ed.) 65th ed. xlii+744 pp. Pitman Publishing Co., 2 West 45th St., New York, N.Y. 1954. $3.00.

Chapters on pipes, beams, columns, springs, etc., bearings and mechanical transmission, cranes and lifting tackle, pyrometry, metallurgy, steam, steam generation, steam engines, steam turbines. Also locomotive practice, condensers, gas and oil engines, gas turbines, air compressors, air and ventilation, hydraulics, machining of materials, modern lubrication, welding and cutting, industrial hygiene and unified screw threads.

Brief technical dictionaries for German- French- and Spanish-English engineering terms. List of technical journals, their source and cost.

Nickel in Iron and Steel . . A. M. Hall. xii+595 pp. John Wiley & Sons, Inc. 440 Fourth Ave., New York 16, N.Y. 1954. $10.00.

Reviews and correlates all important published data on nickel as an alloying element in steel and cast iron. Includes information on occurrences and refining of nickel, physical properties of steels containing nickel, structure and heat treatment of wrought and cast nickel steels, effect of nickel on various engineering properties, corrosion and welding of nickel steels, effect of nickel on constitution of cast iron, its tensile strength, and its hardness. 784 bibliographic references.

The Structure of Metals and Alloys . . William Hume-Rothery and G. V. Raynor. viii + 346 pp. 274 fig. 29 tables. The Institute of Metals, 4 Grosvenor Gardens, London, S.W.1, England. 3d ed., 1954. $5.50.

Electronic background to metallurgy, crystal structure of elements, atomic radii and some physical properties of the elements, primary metallic solid solutions, intermediate phases in alloy systems, structure of alloys of iron, and imperfections in crystals, and deviations from the ideal lattice treated on an elementary level such that prior knowledge of higher mathematics and crystallography are not necessary.

The Birth and Development of the Geological Sciences . . Frank Dawson Adams. v + 506 pp. 79 fig. Dover Publications, Inc., 920 Broadway, New York 10, N.Y. 1954. Paperbound $1.95, clothbound $3.95.

Traces history of geological sciences from the earliest period in which we have any written records in Europe, that of the Greeks, until 1825 when Historical Geology began its rapid development.

Further chapters discuss paleontology, origin of metals and their ores, origin of mountains, earthquakes, origin of springs and rivers, and quaint stories and beliefs. **Symposium on Effect of Temperature on the Brittle Behavior of Metals with Particular Reference to Low Temperatures.. ASTM. vi + 474 pp. 334 ref. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. 1954. $7.50.**

Twenty-seven papers cover the following broad fields: the evaluation of brittle failures in ships and engineering structures, criteria of metal behavior for design engineers, metallurgical and mechanical factors, significance and reliability of notch toughness tests, and certain aspects of current research including new data on titanium, quenched-and-tempered steels at high strength levels, and several types of cast irons.

Titanium in Iron and Steel.. George F. Comstock. xii + 294 pp. 282 ref. John Wiley & Sons, 440 Fourth Ave., New York 16, N.Y. 1955. $6.00.

A critical review of important published data on titanium as an addition to steel and cast iron. Begins with general discussion on titanium, sources, properties, etc. then examines effects of element on properties and structure of carbon and alloy steels and cast irons.

The deoxidizing effectiveness of titanium and its action on the nitrogen, sulphur, and carbon in iron and steel are explained. Bibliography by year of publication.

Metals Reference Book.. 2d ed. Colin J. Smithells. Vol. I xvi + 549 pp. Vol. II xv + 451 pp. Intersci-

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ence Publishers, Inc. 250 Fifth Ave., New York 1. 1955. $25.00.

Chapters on casting alloys and foundry data, refractory materials, fuels, heat treatment, corrosion, finishing, welding, and numerous other subjects pertaining to structure, properties, and testing of metals.

Introductory tables include abbreviations, first aid, weights and measures, conversion factors, corrosion conversion factors, temperature conversion table, and mathematical formulae.

References to original sources at end of each chapter.

Brand of the Tartan.. Virginia Huck. xiv + 260 pp. Appleton-Century-Crofts, Inc., New York. 1955. $3.50.

The story of Minnesota Mining and Manufacturing Company covers roughly the first half of this century. This well illustrated book describes the company from the time of its birth and failure as a mining company through its beginning and development as a manufacturing company to the present time when it handles 25,000 different items.

Italian-English, English-Italian Technical Dictionary.. 3d ed. Renzo Denti. xiv + 1173 pp. Casa Editicle Libreria, Ulrico Hoepli, Corso Matteotti 12, Milan, Italy. 1955.

Includes, among other subjects, aeronautics, chemistry, railways, electroplating, oil industry, civil engineering, machine tools, plastics, mechanics, metallurgy, mining, optics, radio, printing, textiles, etc.

Also gives technical abbreviations, conversion factors, tables of measurements and equivalents, table of chemical elements. 70,000 technical terms.

Basic Lubrication Practice.. Allen F. Brewer. xiv + 286 pp. Reinhold Publishing Corp., 430 Park Ave., New York 22. 1955. $6.75.

Covers lubricants for bearings, gears, chains, wire rope, flexible couplings, cams, steam turbines and cylinders, internal combustion engines, power plant auxiliaries, electric motors, and other machinery.

Literature references at end of chapters for further reading. Numerous charts, tables, and illustrations.

References on Fatigue (1954).. ASTM 29 pp. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 1955. $1.85.

Special Technical Paper No. 9-F is a list of 227 references to articles published in 1954 dealing with fatigue of structures and materials. References are arranged so that pages can be cut and filed according to any desired plan. Brief abstracts are included in many cases.

Metalurgia General.. Emilio Jimino and F. R. Morral. 2 vol. 1323 pp. Aguilar, Serrano 22, Madrid, Spain. 1955. 375 pesetas ($9.00)—payment should be arranged through a bank.

Written in Spanish and issued as a publication of the University of Madrid this work on general metallurgy will help train scientists, engineers, and technicians in Spanish speaking countries.

Appendix contains illustrated description of metallurgical laboratories at the Univ. of Madrid.

Directory of Comercial and College Testing Laboratories.. vii + 39 pp. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. 1955 $1.00.

Successor to *Directory of Commercial and College Laboratories* published in 1947 by the National Bureau of Standards. Lists testing laboratories equipped to test on a fee basis. Information given concerning 278 commercial labs and 86 college labs.

Code system of letters and numbers is used to show types of tests and products tested.

Techniques of Plant Maintenance and Engineering—1955.. Proceedings of the Technical Sessions held with the Sixth National Plant Maintenance and Engineering Show. 218 pp. Clapp & Poliak, Inc. 341 Madison Ave., New York 17. $7.50.

Papers, discussion, and round table discussions from technical sessions which covered all phases of maintenance such as personnel, organization, training, management, costs, and sanitation.

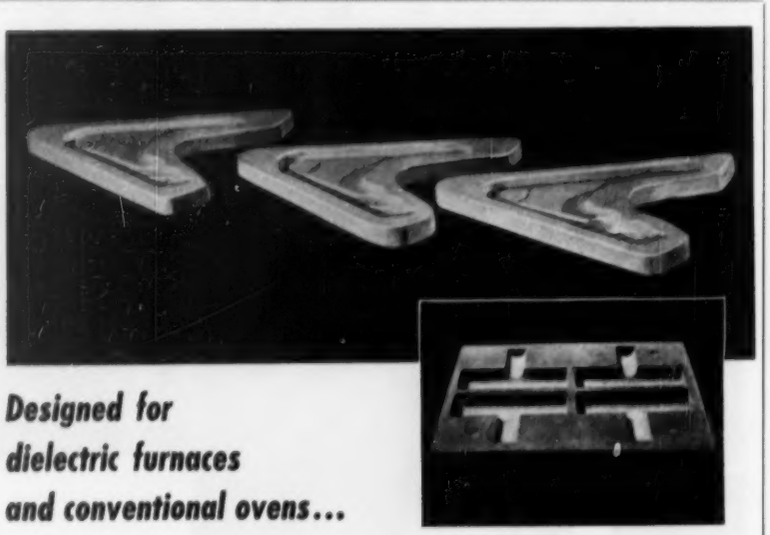
Everything *and* the Kitchen Sink . . Farrar, Straus & Cudahy. 160 pp. Philip Lesly Company, 100 W. Monroe St., Chicago 3, Ill. 1955. $4.00.

Account of growth of American industry from 1855 to 1955 featuring birth and development of Crane Co. Numerous illustrations.

Electric Melting and Smelting Practice.. A. G. E. Robiette. vii + 347 pp. 121 fig. biblio. Charles Griffin & Co Ltd., 42 Drury Lane, London, WC 2, England 1955. 50 s.

Deals with construction and operation of all the principal types of electric furnaces and discusses many new processes and techniques. Explains electrochemistry of the different processes and gives special attention to changes in design of plant due to increasing size and mechanization.

NANCY PURCUCKER, *Librarian American Foundrymen's Society*



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Missouri Regional

continued from page 68

man L. Peukert, Carondelet Foundry Co., St. Louis, presided; session secretary was Willis Mook, Bethlehem Supply Co., Tulsa, Okla.

Steel session speaker was Wm. Bean, Jr., consultant, Detroit. His subject was *"Steel Casting Design."* Presiding was L. A. Kleber, General Steel Castings Co., Granite City, Ill. Phillip Spooner, Missouri Steel Castings Co., Joplin, Mo., served as secretary. Non-ferrous speaker R. A. Colton, Federated Metals Div., American Smelting & Refining Co., Barber, N. J., discussed *"Practical Gating and Risering of Non-Ferrous Castings."* Chairman and secretary of the session were, respectively, E. C. Austin, Jr., National Aluminum & Brass Co., Independence, Mo., and J. R. Bodine, Bodine Pattern & Foundry Co., St. Louis.

Mr. Walton discussed specific control procedures and warned that the starting point of quality control is management which must recognize that quality requirements are becoming more rigid. You cannot inspect quality into a casting and you cannot reduce unknown costs, he stated.

Mr. Bean described modern techniques for casting design such as strain gauges and brittle lacquer techniques, and told how they can be used in improving casting quality and in product development.

Gating and risering practice is the dominant influence in production of sound copper-base alloys, Mr. Colton said. Design gating systems to minimize turbulence and agitation, distribute the metal so as to avoid overheating any portion of the mold or core, and use the drag-runner cope-ingate system. He recommended using chills, insulated risers, and hot topping compounds to improve solidification patterns of castings.

An Ozark Hillbilly Jamboree rounded out the first day's meetings.

Lead-off session the second day dealt with *"Practical Mechanization for Small Foundries"* with C. V. Nass, Beardsley & Piper Div., Pettibone Mulliken Corp., Chicago, as speaker. Presiding was W. L. Neville, Neville Foundry Co., Kansas City,. Mo., with Dr. A. W. Schlechten, School of Mines & Metallurgy, as secretary. Mr. Nass outlined steps leading to a decision to mechanize and to selection of equipment, and showed a motion picture of typical small-shop equipment installations.

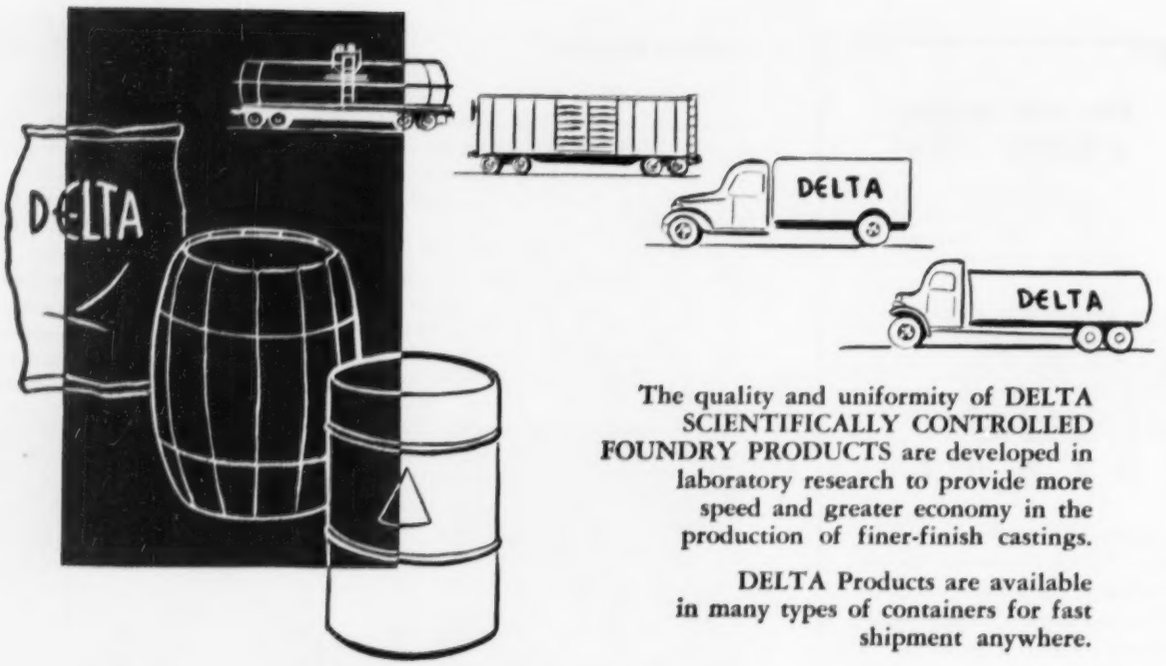
A second round of three simultaneous sessions concluded the technical program. Gray iron speaker was W. W. Kerlin appearing for C. R. Austin, Meehanite Metal Corp., New Rochelle, N. Y. Dr. Austin's paper *"How to Heat Treat Gray Iron"* is in this issue, pages 30-33. F. E. Fogg, Acme Foundry & Machine Co., Coffeyville, Kan., presided with John O'Meara, Banner Iron Works, St. Louis, as secretary.

At the steel session, J. B. Caine, consultant, Wyoming, Ohio, spoke on *"Steel Castings vs. Forgings."* Presiding was D. W. McArthur, Oklahoma Steel Castings Co., Tulsa; secretary was R. H. Jacoby, St. Louis Coke & Foundry Supply Co. Harry C. Ahl, Jr., National Bearing Div., American Brake Shoe Co., Meadville, Pa., spoke on *"Economics of Quality Control in the Bronze Foundry"* at the non-ferrous session. Frank Gilbert, Gilbert Brass Foundry Co., St. Louis, presided while Henry C. Deterding, Sonken-Galamba Corp., Kansas City, Kan., acted as secretary.

Castings cannot compete with forgings from the standpoint of strength if tensile strength is used as a measure of tensile ductility, Mr. Caine said at the steel session. Tensile ductility not only underevaluates cast metals, it overevaluates wrought metals, he declared. There is ample evidence that metal structures fail with a brittle fracture although the material looked good in the tensile test, he pointed out.

Instead of tensile strength, Caine stated, we should measure service strength by means of notch toughness and fatigue strength. This puts emphasis on quenching to develop notch toughness and elimination of crack-like defects for better fatigue strength.

Quality control, Mr. Ahl said, is the science of repeatedly producing quality bronze castings at the least possible production costs. Such pro-



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grams can be established without a metallurgist if top management has a desire to improve its operating practice, he pointed out.

Ahl noted that a quality control program does not call for a large outlay of cash and cited simple control tools such as the AFS fracture test for melt quality, the zinc test for combustion control, pyrometers for temperature measurement, moisture testing equipment for sand, and careful visual inspection and correlation of defectives with operating conditions.

At the final luncheon meeting foundrymen heard AFS President Bruce L. Simpson, National Engineering Co., Chicago, Wm. W. Maloney, AFS general manager, and Gale Bullman, School of Mines athletic director. Mr. Hunt again presided.

AFS is successful because it provides an opportunity to serve others. It would not last long if based on selfishness, Mr. Simpson said, in outlining the purposes of the organization.

Mr. Maloney pointed out that AFS belongs to the casting industry and that its activities take the direction indicated by the desires of the membership. He announced the formation of the Connecticut Chapter and the Southern Section of the Chesapeake Chapter (page 85).

Ladies attending the conference were entertained in the Wilson home with Mmes. Wilson and Schlechten as hostesses.

Conference committee members in addition to Mr. Kammerer and Dean Wilson included: C. R. Culling, Carondelet Foundry Co., St. Louis; Messrs. Hunt, Westwood, Deterding, McArthur, and Mook; Drs. Schlechten and Eppelsheimer; Fred J. Boeneker, Bronze Alloys Co., St. Louis; George L. Mitsch, ACF Industries, St. Louis; Lloyd H. Canfield, Canfield Foundry Supplies & Equipment Co., Kansas City, Kan., and Erhard Neumann, MSM student.

Others active in Missouri Valley Regional Conference preparations were: Edward O'Brien, Oklahoma Steel Castings Co., Tulsa; Edward Hayden, Neville Foundry Co., Kansas City, Mo.; Robert C. Kane, Midvale Mining & Mfg. Co., St. Louis; and J. R. Bodine.

Issue Long Awaited Metal Casting Text

■ PRINCIPLES OF METAL CASTING, just released, is a theoretical and practical college-level text, advanced apprentice text, and comprehensive reference for operating foundrymen, metallurgists, and design engineers that covers the foundry field more completely than any book yet compiled.

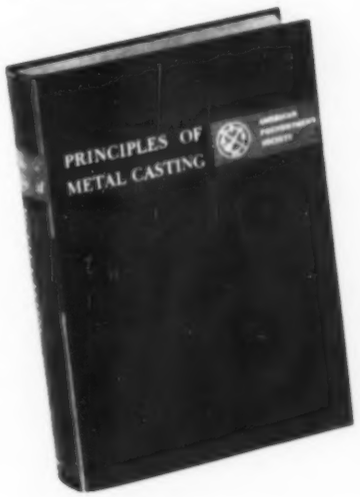
Richard W. Heine, associate professor and P. C. Rosenthal, head, Department of Mining and Metallurgy, University of Wisconsin, prepared this unique book in cooperation with the Textbook Committee of the Education Division of the American Foundrymen's Society.

P. C. Rosenthal

R. W. Heine

For the most part, this book treats the mechanics of practice in one chapter then metallurgical aspects in the next. This facilitates teaching metallurgical engineers as well as mechanical engineering students. Also, this makes it easier to locate information with the desired emphasis.

Much information on the solidification of metals which has recently become available is included in a chapter on that subject.



Discussed are: growth of solid grains, heat evolution and transfer, and dimensional changes. Variables considered are: mold material and thickness, mold geometry, metal thickness, and metal properties such as thermal conductivity and solidification range, and heat transfer from mold to atmosphere.

But you don't have to read this chapter to understand the next, Pouring and Feeding Castings, which includes a less involved approach to solidification, allowing the reader to avoid the preceding chapter, yet appreciate material presented.

Extensive lists at the end of each chapter refer the reader to literature on much more complete Treatments of the principles and their scientific development.

Much of the information on pouring castings is from AFS-sponsored research on gating. Gating system definitions presented here are the work of one of the many AFS technical committees whose works are incorporated.

All-in-all, this practical chapter discusses pouring, with primary concern over properties of the liquid metal; feeding, with emphasis on getting this liquid metal to the proper place at the proper time; and solidification—changes during liquid to solid transformation.

Thirteen of the 25 chapters deal with the casting of the major metals. As the treatment of each is similar, a discussion of the section on steel indicates the way each is handled.

The chapter on steel foundry practice discusses molding processes and sands; cores—hot tears, penetration, and washes; and gating and feeding. Also: melting, cleaning, welding, inspection, and properties and uses of cast steels.

Due to high pouring temperatures, special attention is given to refractories, ladles, molding sands, metal transfer, and pouring.

The rather intricate procedure of melting and refining steel is so specialized that it is considered in much greater detail in the following chapter, where having described the various steel making processes and defined the stages of melting, oxidation and refining, and deoxidation, each stage is considered from the standpoint of the major reaction involved and differences among the processes.

Still another chapter is devoted to the metallurgy of cast steel, covering composition, structure, heat-treatment, and alloy steels.

In general, the reader finds foundry practice and metallurgical aspects of each metal treated separately. Special features of malleable iron are covered in a chapter apart from the cast iron family.

Members of the Textbook Committee who assisted the authors are: Prof. William H. Ruten, Polytechnic Institute of Brooklyn, New York, chairman; Prof. D. S. Eppelsheimer, Missouri School of Mines, Rolla; Frank B. Rote, technical director, Albion Malleable Iron Co., Albion, Mich.; Prof. Richard Schneidewind, University of Michigan, Ann Arbor; and Frank W. Shipley, foundry manager, Caterpillar Tractor Co., Peoria, Ill.

Additional assistance was given by Charles F. Walton, formerly with Case Institute of Technology, Cleveland, now technical director, Gray Iron Founders' Society, Cleveland.

PRINCIPLES OF METAL CASTING is a 6½ x 9¼-in. case-bound volume containing 639 pages and over 300 illustrations, tables, and charts. Its price is $7.50; if remittance accompanies the order, postage will be prepaid. Write to: Book Department, American Foundrymen's Society, Golf & Wolf Roads, Des Plaines, Ill.

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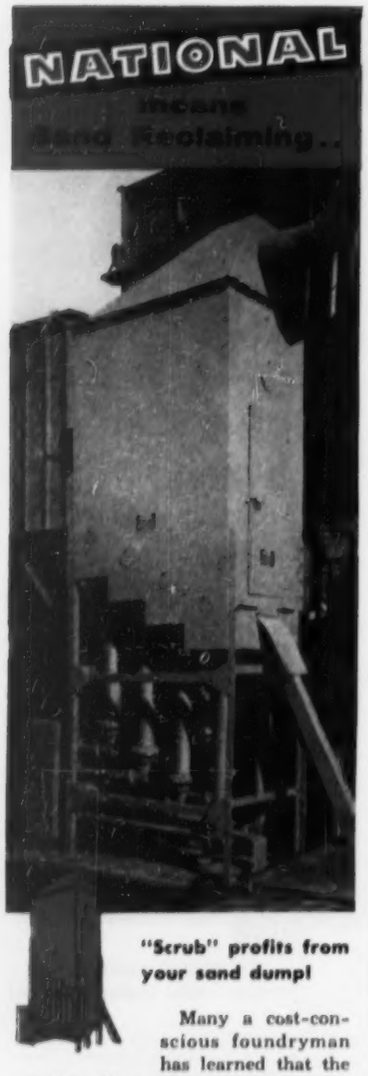

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CIRCLE NO. 111, PAGE 79-80

foundry trade news

Electric Steel Foundry Company, Portland, Oregon, has announced the creation of a new export division, **ESCO International.** Headquarters of the new division will be in New York.

Urick Foundry Company, Erie, Pa., has recently published a 16-page, illustrated booklet describing production methods in the Urick plant.

Walworth Company has announced acquisition of the assets and business of Alloy Steel Products Company, Inc., Linden, N. J., producer of stainless steel and corrosion resistant valves.

Cast Iron Soil Pipe Institute has announced three new member companies. They are **American Brass and Iron Foundry,** Oakland, Calif.; **American Foundry,** Los Angeles; and **Herco Foundry Company,** South Gate, Calif.

Harbison-Walker Refractories Co. has opened a new plant at Leslie, Md., to produce silica refractories.

Indiana Products Co., Kokomo, Ind., has announced that they will distribute equipment for the carbon dioxide mold and core hardening process.

National Lead Co. has announced the formation of a new Australian subsidiary, Mineral Deposits Pty. Ltd. Mineral Deposits will mine, concentrate, and export rutile and ilmenite. Other minerals produced will be zircon and monazite.

Clark Equipment Co. has announced that a parts depot will be established in the San Francisco-Bay area.

Mexico Refractories Co., Mexico, Mo., and its founder and president, J. B. Arthur, have been honored on the occasion of its 25th anniversary. The company has published a brochure describing its growth and development.

Foundry alloying materials produced by **Climax Molybdenum Company** will now be distributed

A record 130 students attended the three-day Harry W. Dietert Sand School in Detroit this year. Enrollment represented 18 states and Canada.

Better castings are our business.

Foundries big and small have taken advantage of the background of practical foundry experience and engineering skill that go into every National sand and mold handling job.

Experience has taught us to look on a molding system as a machine to produce *castings.* The function, operation, service and maintenance of each part must be considered and successfully worked out if the "machine" is to operate efficiently. That's why National offers a *complete* service, not a collection of catalog items. It begins with a thorough analysis and *carries through* to design, manufacture and installation. You get a coordinated unit—a machine to produce castings.

Write today for your free copy of the National Data Book for Engineers.

NATIONAL Engineering Company
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CIRCLE NO. 112, PAGE 79-80

in New England and middle Atlantic seaboard areas by Whitehead Metal Products.

International Nickel Company has moved the headquarters of their development and research division's central Atlantic coast technical field section from New York to Abington, Pa.

Construction has started on a $1,285,000 manufacturing plant for the **Norton Company**. The plant is located in Huntsville, Ala.

Ajax Engineering Corp., Trenton, N. J., has announced an agreement with Otto Junker G.M.B.H., Lammersdorf, Germany, and Birlec Ltd., Birmingham, England, for development and marketing of a line-frequency, coreless, induction melting furnace.

Mackintosh-Hemphill Co., Pittsburgh, Pa., has sold all of its assets to the **E. W. Bliss Co.** Mackintosh-Hemphill, which now becomes a division of Bliss, will still continue to operate its plants in Pittsburgh and Midland, Pa., where it manufactures its lines of cast alloy steel and iron rolls, rotary straighteners, slag handling equipment, and heavy duty engine lathes for primary producers of ferrous and non-ferrous mills.

Continental Foundry & Machine, East Chicago, Ind., has been authorized by O.D.M. to depreciate at the rapid rate 65% of improved facilities for producing gray iron and steel castings valued at $467,350.

Rockwell Manufacturing Co., Pittsburgh, Pa., has changed the name of its Canadian subsidiary, Callander Foundry & Manufacturing Co., Ltd., Guelph, Ont., to **Rockwell Manufacturing Co. of Canada, Ltd.**

Lithium Corp. of America, Inc., has announced a general price reduction effective immediately on lithium carbonate, hydroxide and chloride, lithium metal, lithium amide and hydride, and nine special ceramic compounds.

A new series of corrosion resistant precipitation hardenable stainless steel alloys has been announced by the research division of **Coopr Alloy Corp, Hillside, N. J.**, Developed by N. S. Mott, chief metallurgist,

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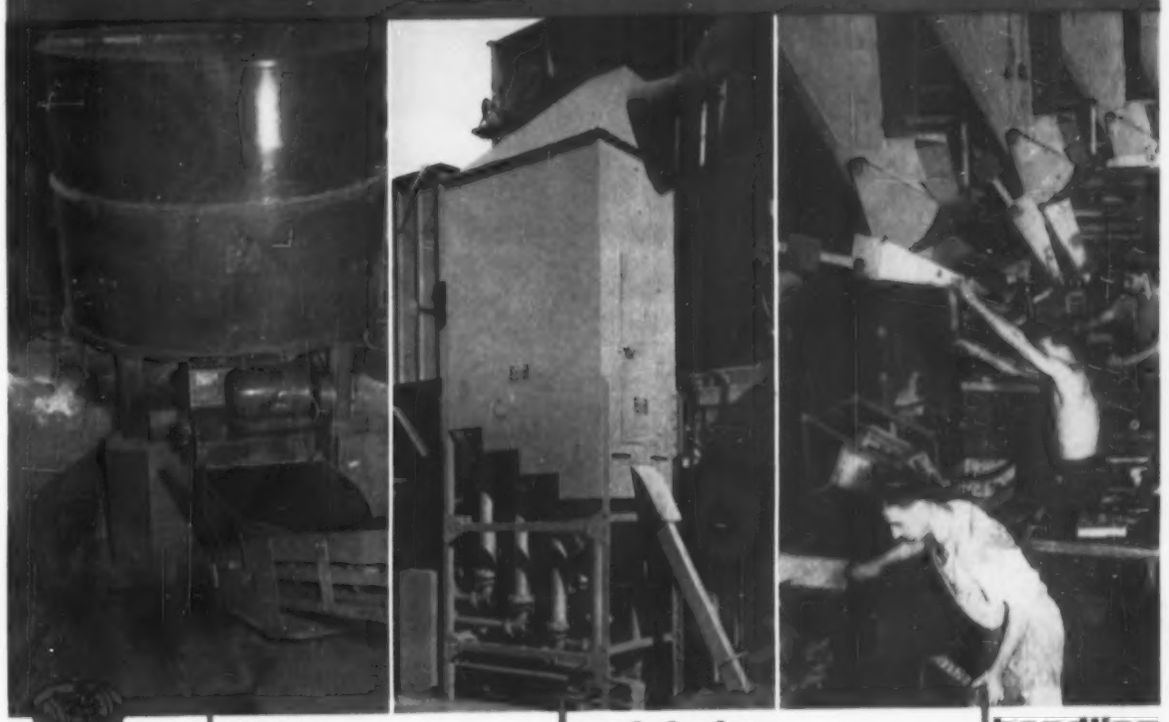

mixing | reclaiming | handling

Just as the process of mulling has made possible the use and benefits of synthetic molding sand, so have the efforts of National Engineering Company been continued toward the development of products and practices that help you make better use of sand:

• Today's Simpson Mix-Muller has been improved to provide infinite control over muller pressures. Maximum pressures are automatically developed as the sand increases in strength towards the end of the cycle.

• The National Pneumatic Sand Recovery System has made the dry recovery of "burnt out" sand practical — and within the economic and physical reach of most foundries.

• The services of your National Engineer have been broadened through the years to offer practical, experienced assistance in every phase of sand handling, molding and casting practice.

• A subsidiary company, National Dust Collector Corporation, now offers a wet type dust collector that can cite efficiencies of 98.2 to 99.1% in collecting foundry shakeout dust.

These are but a few of the reasons why when you *buy National* you buy products of the practical foundrymen . . . made for the foundry, by foundrymen.

If your problem is in sand preparing, sand handling, mold handling or excessive waste sand — call your National engineer today.

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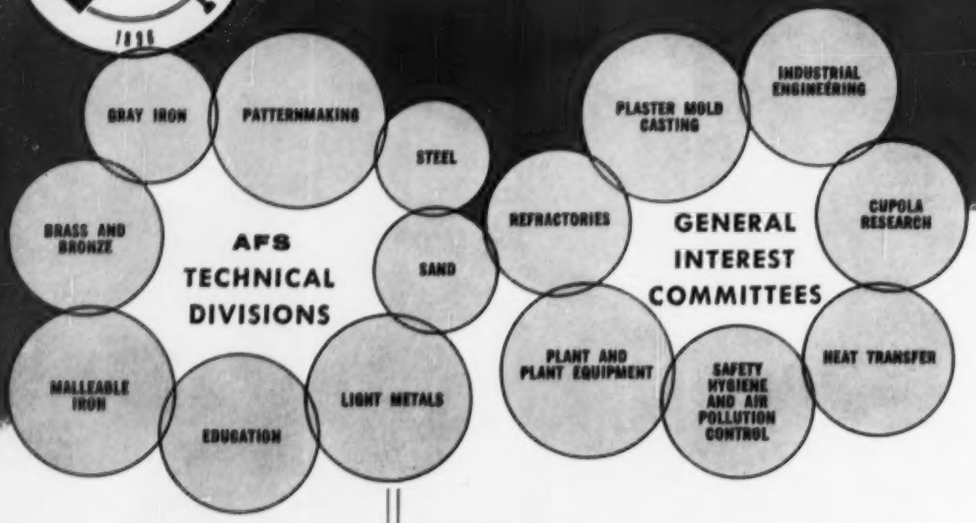
CIRCLE NO. 113, PAGE 79-80

Inseparable link to

CASTINGS PROGRESS



Membership in the American Foundrymen's Society offers unending opportunities for knowledge, ideas, budgeting and planning through the cooperative efforts of recognized authorities. In addition to a constant source of technical-practical help, AFS Membership offers the greatest of all dividends . . . personal contacts with leaders in the same Industry.

The constant interest and active participation of all members, be they executives, supervisors, or foundry workers, is constantly sought and their ideas and opinions welcomed. AFS is essentially a democratic and cooperative organization wherein the will of the majority, as expressed through officers elected by the membership, necessarily governs its every activity and directs its progress.

The benefits of AFS Membership are available in four different Classifications:

SUSTAINING . . . $300

Sustaining Membership is manifestation of the faith of leading foundry companies in the technical work, research activities and educational endeavors of the Society. The extent of the overall program is directly dependent upon available resources derived from Sustaining Membership dues. Participating companies, in turn, have unlimited access to all AFS findings and the privilege of making it possible for any number of company employees, regardless of location within a country, to hold Personal AFS Membership at minimum dues of $10.

COMPANY . . . $100

Company Membership represents an investment on the part of the employer for full membership service for an officially designated representative of the Company, plus the privilege of having employees in all offices or plants, located within the confines of the local AFS Chapter wherein the Company Membership is held, to become Personal Members at minimum dues of $10.

PERSONAL . . . $20

Exceptions: (1) Eligible employees, explained above, of Sustaining or Company Members $10

(2) Individuals engaged solely in educational and government work (U.S. and Canada) $10

JUNIOR . . . $4

The Junior Classification applies to individuals who have not yet reached their 25th birthday (evidence of birth date must be submitted).

After 60 years of service to an International Membership, AFS is acknowledged at the "Inseparable Link to Castings Progress."

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GOLF AND WOLF ROADS, DES PLAINES, ILLINOIS

the series is designed to meet the following needs: PH55A, a high strength and high hardness alloy with fair ductility, for erosion and abrasion resistance or for stressed parts in corrosive applications; PH55B, a ductile high strength alloy of medium hardness, for shock resistance and high stresses in corrosive applications; PH55C, a high hardness alloy of low ductility for non-stressed, corrosion resisting parts; PH20, a gall resistant alloy with superior corrosion resistance. All three alloys in the PH55 series are variations of the 19 chromium –9 nickel analysis. Cooper Alloy type PH20 is a precipitation hardenable version of the 20 chromium –29 nickel type 20 alloy.

General Electric Welding Dept., York, Pa., has established a new direct-sales office and warehouse in Buffalo, N. Y. W. G. Leaman has been named manager of the new office.

Hydro-Blast Corp. has moved to a new and expanded facility at 10265 Franklin Ave., Franklin Park, Ill.

Wilputte Coke Oven Div., Allied Chemical & Dye Corp., New York, announced that its licensees, Gibbons Brothers, Ltd., Dudley, England, have received a contract for a battery of coke ovens from South Durham Steel and Iron Co., Ltd., England.

Stanford Research Institute, Stanford, Calif., has published its annual report as an interesting 49-page booklet.

John Wilfert Co., Brooklyn, New York, has been appointed as authorized distributors for Cooper Alloy valves, fittings, and accessories.

Construction has begun on a $5,000,000 engine foundry for **Ford Motor Co., Ltd.,** Dagenham, England. A contract for design and construction has been awarded to the H. K. Ferguson Co. of Great Britain, Ltd., subsidiary of H. K. Ferguson Co., Cleveland. Scheduled for completion in 20 months, the project is part of a $168 million dollar expansion program recently announced by the British affiliate of Ford. The foundry will be similar to one built by Ferguson in the Cleveland area for the Ford Motor Co., in 1951.

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for the asking

Core Box Seal

Dike-O-Seal, continuous seal molded in the core box, is said in new bulletin to eliminate blow-by and core and box repair caused by blow-by. Lower closing pressures are possible, cores have consistant permeability, and may be more intricate. Service includes installation of seals on old, worn boxes, on new boxes that have not yet been faced; also (and preferable) quotation from blueprint. Complex boxes with seals are illustrated and names of users are listed. *Dike-O-Seal*

CIRCLE NO. 43, PAGE 79-80

Core Coating

Bulletin says that Delta Hi-Temp Wash for sand cores does not fuse or sinter below 3200 F. It doesn't precipitate easily, is easy to apply by any method, and won't absorb moisture when dry. Penetration prevents flaking, peeling, and scabbing. It's non-reactive with molten ferrous metal and liberates no gas. *Delta Oil Products Co.*

CIRCLE NO. 44, PAGE 79-80

Sand Mixer

Here is the story of the Speedmullor. 36-page Bulletin 1220 discusses reasons for sand mulling and shows how techniques have developed. Everything about the Speedmullor, of course, is thoroughly discussed and illustrated. Many diagrams of installations and tables of data help to visualize applications of the mullor and many special controls and accessories. *Beardsley & Piper Div., Pettibone Mulliken Corp.*

CIRCLE NO. 45, PAGE 79-80

Corundum-Base Refractory

Bulletin 317 tells of monolithic roofs of Taycor corundum-base ramming mix for 1000-lb basic, direct arc furnace melting a variety of heat-resistant alloys. Says service life is two to three times longer, depending on alloy melting. Covered also are crucibles, heat treat refractories, and cements. *Chas. Taylor Sons Co.*

CIRCLE NO. 46, PAGE 79-80

Enclosed-Tip Thermocouples

Line of enclosed tip thermocouples for non-ferrous melting practice, including stationary and portable units, replacement units, and parts and price list, are described in 8-page bulletin which says this equipment can be used with any standard type of indicator intended for use with chromel-alumel couples. *L. H. Marshall Co.*

CIRCLE NO. 47, PAGE 79-80

Overhead Transportation

Ohio Tramrail Systems are designed for handling bulky, heavy, non-uniform products and materials. They cost little to maintain and operate, they free aisle space, and can be made to cover almost every square foot of floor space if need be. They can also be quickly and easily modified to meet changing conditions. 8-page Bulletin 110 also describes a typical foundry layout. *The Forker Corp.*

CIRCLE NO. 48, PAGE 79-80

Monorails and Cranes

Ohio Tramrail systems and cranes are described in Bulletin 107 which shows how a foundry solved its distribution problems. Layout and illustrations. *The Forker Corp.*

CIRCLE NO. 49, PAGE 79-80

Spectrophotometer

The Hilger Recording Infra-Red Spectrophotometer H 800 incorporating the double beam in time system is described in Catalog CH 310. *Hilger & Watts Ltd.*

CIRCLE NO. 50, PAGE 79-80

Shell Molding Film

15-min 16-mm, sound, color movie describes new, fully integrated shell molding system at the Link-Belt Ewart plant. Film follows operation step by step from sand and resin preparation through pouring and shakeout. *Link-Belt Co.*

CIRCLE NO. 51, PAGE 79-80

Non-Ferrous Test Bars

New booklet, "How to Make Good Test Bars," covers the design and making of aluminum alloy and copper base test bars. Melting and pouring procedures are emphasized, and recommended temperatures, pouring procedures, and shakeout times are listed for various alloys. *George Sall Metals Co., Inc.*

CIRCLE NO. 52, PAGE 79-80

Crucible Melting Hints

No. 5 in a series on "getting the most from crucible melting" covers types of fuel, types of burners, burner location and combustion area, air pressure, furnace atmosphere, atmospheric determining methods, and controls. *Crucible Manufacturers' Association.*

CIRCLE NO. 53, PAGE 79-80

continued on following page

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CIRCLE NO. 95, PAGE 79-80

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Alloy Line

24-page, pocket-size booklet presents the standard master alloys and special alloys produced by Alter Co. for use by iron, steel, and non-ferrous casting industries. Also contains melting points of some metallic elements, density and weight of various materials, and temperature conversion tables. *Alter Co.*

CIRCLE NO. 54, PAGE 79-80

Moisture Tester

The highly portable Speedy Moisture Tester, described in Bulletin 37, indicates free moisture in a test that takes only 35 to 40 seconds. Oils, binders, and additives of a volatile nature are not affected. Accuracy is guaranteed to 0.2 of one per cent. *Alpha Lux Co., Inc.*

CIRCLE NO. 55, PAGE 79-80

casting | through the ages

The almond-shaped
LEADEN PELLETS USED SO EFFECTIVELY IN BATTLE BY THE ARMY SLINGERS OF ANCIENT GREECE, WERE CAST IN QUANTITY IN STONE MOLDS HAVING MANY PELLET-SHAPED PERFORATIONS CONNECTED ONE TO ...
...ANOTHER BY CHANNELS. WHEN REMOVED FROM THE MOLDS THESE PELLETS WERE JOINED BY TINY LEADEN STEMS GIVING THEM THE APPEARANCE OF BUNCHES OF GRAPES.
IN THE EARLY 1800's PIONEER AMERICAN FURNACEMEN FREQUENTLY TESTED BLAST TEMPERATURE BY THE USE OF LEAD AND ZINC STRIPS. A BLAST THAT JUST MELTED THE LEAD WAS NOT CONSIDERED HOT ENOUGH; ONE THAT MELTED THE ZINC WAS DEEMED TOO HOT.
Odd Bits
PROBABLY THE WORLD'S FIRST BRONZE BEARING WAS AN ASSYRIAN CUP CASTING, MOLDED ABOUT 900 BC., ON WHICH SWUNG A BRONZE SHEATHED WOODEN DOOR EIGHT FEET WIDE, THREE INCHES THICK, AND TWENTY-SEVEN FEET HIGH.
As Early As 1740, CAST IRON CYLINDERS PURCHASED AT £20 (ABOUT $150.00) REPLACED BRASS CYLINDERS COSTING £250 EACH IN NEWCOMEN'S STEAM ENGINES USED BEFORE WATT TO PUMP WATER OUT OF ENGLAND'S COAL MINES.

Table-Type Blast

The plain, table-type, airless blast cleaning machine described in Bulletin 100-D is especially designed for handling a wide range of job shop work, particularly that which does not have too many pockets or vertical edges. Said to be ideal for flat or fragile work requiring careful handling. One operator loads and unloads while the continuously rotating table carries work through the cleaning operation. *Wheelabrator Corp.*

CIRCLE NO. 56, PAGE 79-80

Fork Lift Trucks

Advantages of the TowmoTorque Drive automatic transmission for fork lift trucks are given in new booklet. A creep-control feature is said to enable the operator to "inch" his truck along smoothly while maintaining high engine speed for full lifting power. *Towmotor Corp.*

CIRCLE NO. 57, PAGE 79-80

Conveyors

Bulletin illustrates various conveyor applications and lists users of roller, belt, wheel, apron, and live roller conveyors, ball transfers, Alligator Switch, roller spirals and spiral chutes, pusher bar and vertical lifts. *Logan Co.*

CIRCLE NO. 58, PAGE 79-80

Charging-Melting-Pouring

Automation, and recuperative, hot blast sealed top cupola are illustrated in bulletin 148-C which also tells of the planning, engineering, manufacturing, and erection activities for charging, melting, and pouring systems of the *Modern Equipment Co.*

CIRCLE NO. 59, AGE 79-80

Cast Iron Art

Handsomly printed, 13-page booklet presents the Lamprecht Collection of Cast Iron Art; a story of cast iron in its more beautiful and esthetic form. Illustrated are 18th century stove, jewelry, portraits, busts, and household articles. Originally published in 1941 by American Cast Iron Pipe Co., made available by *United Oil Mfg. Co.*

CIRCLE NO. 60, PAGE 79-80

Refractories

Bulletin No. 350 describes the Hydrecon line of castable refractories for temperatures up to 3000F, and gives technical data tables for each product on modulus of rupture, linear change, cold crushing strengths, and installation requirements. Mixing instructions are given and applications are shown. *J. H. France Refractories Co.*

CIRCLE NO. 61, PAGE 79-80

Foundry Engineering

Professional Foundry Engineering, 8-page Bulletin 101, illustrates and outlines the comprehensive combination of services developed for the castings industry by the firm. Included are foundry, industrial, and architectural engineering, modernization, mechanization, automation, wage incentives, cost control, budgeting, and surveys. *Lester B. Knight & Associates, Inc.*

CIRCLE NO. 62, PAGE 79-80

Significance of Graphite

18-page "Engineered Performance" tells how advanced process technology assures dependability and uniformity of GLC electrodes, anodes, mold stock, and graphite specialties—in the growing significance of graphite. *Great Lakes Carbon Corp.*

CIRCLE NO. 63, PAGE 79-80

Cartridge Core Blower

Bulletin illustrates and describes the Redford cartridge-type bench core blower. Says this machine is quickly and economically installed and doesn't use a large volume of air. Extreme flexibility is claimed for this machine which takes mechanical and air-operated clamping attachments. Seven hints for core blowing are included. *Redford Iron & Equipment Co.*

CIRCLE NO. 64, PAGE 79-80

Continuous Moisture Tester

Bulletin describes an instrument which provides a running record of moisture fluctuations in all sand whether on a conveyor belt or in a bin or hopper. Assessories warn when moisture is too high or too low. *Harry W. Dietert Co.*

CIRCLE NO. 65, PAGE 79-80

Clamshell Manual

How to reeve Erie 2-line buckets for maximum efficiency, for from two to six parts of line, lubrication instructions, assembly and disassembly, and parts instruction are covered in 6-page bulletin 2 L-M. *Erie Strayer Co.*

CIRCLE NO. 66, PAGE 79-80

The Crane and Automation

"Planning the Crane for Its Use in Automation" answers many questions about the place of overhead materials

handling in the trend towards automation. 12-page Bulletin M-30 covers also: fundamentals of good plant operation, basic factors in crane selection, and automatic handling application of cranes. *Whiting Corp.*

CIRCLE No. 67, PAGE 79-80

Melting and Casting Aids

Foseco products and services are brought together in this 48 sheet booklet including coverals, degassers, grain refiners, core and mold coatings, exothermic compounds and procedures for magnesium and zinc practice. Similar products and services for iron and steel practice. *Foundry Services, Inc.*

CIRCLE No. 68, PAGE 79-80

Ferrous Metallurgy Chart

Revised edition of the Tempil Basic Guide to Ferrous Metallurgy (8½ x 11-in. black and white version) shows the principal characteristics of steels (up to 0.9% carbon) through working zones for welding preheat, stress relieving, normalizing, and annealing. Also defines 24 common metallurgical terms and symbolizes grain size change in diagram. *Tempil Corp.*

CIRCLE No. 69, PAGE 79-80

Boron Carbide Handbook

"Handbook on Boron Carbide and Elemental Boron" provides 16 pages of technical information on materials made by the company for use in the atomic energy field. Included are boron for neutron absorption, technical grade boron, boron properties, commercial grades of boron carbide, radiation damage to boron carbide, bonded boron carbide, boron nitride, and metal borides. *Norton Co.*

CIRCLE No. 70, PAGE 79-80

Lithium

Bulletin discusses the cause of porosity in copper-base alloy castings, describes lithium metal and its metallurgical applications. Covers also high conductivity copper castings, copper-base alloys, and nickel, silver, silicon bronze, and similar alloys. Also available is a reprint of the article "Use of Lithium Cartridges". *Lithium Corp. of America, Inc.*

CIRCLE No. 71, PAGE 79-80

Inspection Pays

Inspection should be considered productive machinery, says "Lower Manufacturing Costs"; and furthermore, if it cannot be made to pay for itself, it

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John A. Rassenfoss
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A sound text for a study of the technical aspects of the American foundry industry and an excellent reference manual.

CHIEF METALLURGIST
Angelo Bubic
Sterling Foundry Co.
Every metallurgist, designing engineer, and shop library should possess this book. It not only mentions practically everything in the casting process, but gives references to further information on any subject.

COVERS . . . molding processes including the sand casting methods, shell molding, die and permanent mold casting, investment, etc. Mold materials and construction, molding equipment, solidification of metals, gating and feeding of castings, molding sand technology, cleaning of castings, castings design, metallurgical principles associated with melting, composition of casting alloys and their properties, heat treatment, and metallurgical processing characteristics of foundry practices. No processes other than metal casting are considered.

Principles associated with molding processes and materials and solidification of metals are presented in the first eleven chapters; the principles are then interpreted for the specific casting alloys (fourteen chapters). Special metallurgical principles of melting, alloying, heat treating, and metallurgical processing are confined to portions of the latter fourteen chapters.

Prepared by Richard W. Heine and Philip C. Rosenthal of the University of Wisconsin, Madison, Wisconsin.

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Faced with ever-increasing operating costs and stiff competition, the Athens Stove Works of Athens, Tennessee, looked to modernization for the answer. One of the most significant steps taken was the replacement of coke-fired, hand-fed core ovens with a modern *Foundromatic* dielectric sand core oven.

As a result, production has been greatly increased and core quality improved. Operating fully loaded, the belt of the *Foundromatic* oven travels at a highly productive rate of 32 inches per minute. And because cores produced are free of defects, casting finishes are smoother and cleaning time is reduced.

The *Foundromatic* oven has also helped Athens meet a specific operating condition. Cores set up in molds early in the morning are not poured off until the middle of the afternoon. Because the *Foundromatic* oven produces a thorough bake, moisture pick-up is minimized.

The *Foundromatic* Sand Core Oven Can Pay Off for You With:

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- Reduced Cleaning Time

For all the facts on the Foundromatic *dielectric core oven, call your nearby Allis-Chalmers district office or write Allis-Chalmers, Milwaukee 1, Wis. Ask for Bulletin 15B7306B.*

Foundromatic is an Allis-Chalmers trademark.

ALLIS-CHALMERS

A-4776

CIRCLE NO. 96, PAGE 79-80

is not worthwhile. Booklet (Form 148-2) discusses various uses for nondestructive testing and indicates how a nondestructive testing program can be instituted as a cost reducing, money saving tool. *Magnaflux Corp.*

CIRCLE NO. 72, PAGE 79-80

Copper-Base Developments

Review of prospective improvements in metallurgy and operating practices for non-ferrous foundrymen. 6-page reprint A-201 covers corrosion resistance and strength of the actively developed manganese and aluminum bronzes and the cupro-nickels. *International Nickel Co., Inc.*

CIRCLE NO. 73, PAGE 79-80

Gypsum Story

"Blueprint of Tomorrow", 48-page book, illustrates and describes progress of the firm in providing the building materials for today and the future. This reference story naturally relates gypsum as well as the building industry. *United States Gypsum Co.*

CIRCLE NO. 74, PAGE 79-80

Sillimanite Refractories

New 8-page bulletin, 318, describes Tamul, Tasil, and Tamax brands of super-refractories, discusses properties and applications of these sillimanite-type or bonded mullite special high temperature refractories. *Chas. Taylor Sons Co.*

CIRCLE NO. 75, PAGE 79-80

Waste Disposal

Article reprint describes a fully automatic system for controlling waste disposal in a plating plant. In addition to destroying cyanides, the new system provides for fully automatic neutralizing of acid and alkali waste. Other article gives hints on cutting electroplating costs with proper waste disposal. *Frederic B. Stevens, Inc.*

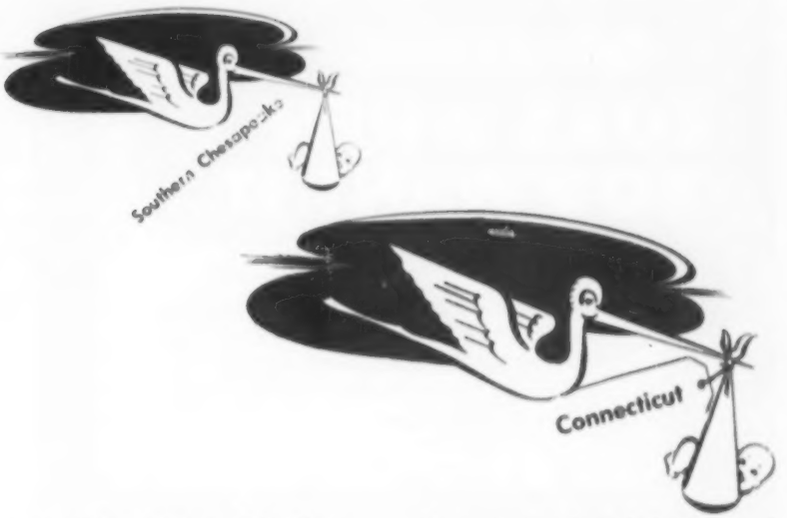
CIRCLE NO. 76, PAGE 79-80

Titanium

Illustrated booklet A-9935, "Titanium," gives up-to-date data on the properties of titanium and discusses methods of fabricating the lightweight metal. Included are tables of mechanical properties of both alloyed and unalloyed grades, and comparative properties of titanium and other pure metals. Commercial applications are

continued on page 92

local foundry news



Start First AFS New England Chapter

■ Connecticut foundrymen met September 20 at the Waverly Inn, Chesire, Conn., and voted to organize the first New England chapter of the American Foundrymen's Society. Chairman D. F. Sawtelle, Malleable Iron Fittings Co., Branford, received a unanimous vote approving submission of a petition for a chapter charter, the new group to be known as the Connecticut Chapter.

Mr. Sawtelle read a number of replies to a questionnaire regarding chapter organization, following which the meeting was addressed by Wm. W. Maloney, national secretary of AFS, who described the Society's various services.

A Steering Committee was then appointed to organize programs and appoint a Nominating Committee for the election of officers and directors. It is expected that the installation meeting and election of chapter leaders will take place in November.

Representatives of some 29 foundry organizations in Connecticut attended the meeting, which was called jointly by Chairman Sawtelle and AFS National Director C. E. Brust, Eastern Malleable Iron Co., Naugatuck, Conn. It is the intention of the group to hold regular monthly meetings in several Connecticut cities.

The meeting was addressed by Robert S. Hull of the Borden Co., New York on *"Operational Problems in Shell Molding."* He stated that shell molding is now being carried on in all cast metals and alloys with the possible exception of low carbon steel. He said that good equipment is essential to good shell molding practice and that equipment for the most part has now outstripped some other aspects of the process.

In discussing patterns the speaker stated that the number of patternmakers in the shell molding field is increasing. Patterns must be "seasoned" by baking with silicones to facilitate their release, he said. He stressed the point that horizontal pouring now is far more prevalent than vertical pouring, and indicated shell casting can be no better than the gating method. The speaker also described various aspects of sand practice for successful shell molding operations.

From Southern Section of Chesapeake

■ Organization of a Southern Section of the Chesapeake Chapter, to hold meetings more convenient to AFS members in Virginia and North Carolina, took place September 23 at a meeting held in conjunction with an inspection visit to the Newport News Shipbuilding & Dry Dock Co., Newport News, Va.

Section officers and members of the steering committee elected at the evening meeting are: *Chairman*—J. S. Parrish, Jr., Richmond Foundry & Mfg. Co., Richmond, Va.; *Vice-Chairman*—L. A. Howell, Newport News Shipbuilding & Dry Dock Co.; *Secretary*—D. E. Matthieu, Kerchner, Marshall & Co., Richmond, Va.; *Treasurer*—Walter J. Kelly, Lynchburg Foundry Co., Lynchburg, Va.

Steering Committee: T. W. Curry, Lynchburg Foundry Co.; C. M. Eckman, Virginia Metal Crafters, Inc., Waynesboro, Va.; Frank G. Carrington, Pontex Pipe Corp., Lynchburg, Va.; Carroll Fisher, General Foundry & Machine Co., Sanford, N. C.; Hampton W. Campbell, Lynchburg Foundry Co., Lynchburg, Va.; R. J. Hanner, Queen City Foundry Co., Charlotte, N. C.; S. W. Richard, Richard Machine Works, Inc., Norfolk, Va.; G. C. Cole, Wysong & Miles Foundry, Inc., Greensboro, N. C.; J. C. Keith, White Foundry Co., Roanoke, Va.; and Dr. W. W. Austin, North Carolina State College, Raleigh, N. C.

The meeting, organized by T. W. Curry, Lynchburg Foundry Co., was attended by some 80 foundrymen from Maryland, Virginia and North Carolina. The morning was devoted to an inspection of the host company's foundry where all the castings for the U. S. S. Forrestal, 60,000 ton aircraft carrier, were cast.

In the afternoon the group toured the machine shop, pattern shop, and dry dock facilities of the Newport News Shipbuilding firm, which was responsible for the complete construction of the Forrestal vessel. While inspection of the ship was cancelled due to delays in the speed runs occasioned by hurricane "Ione," the group witnessed the docking of the vessel following its successful trial runs.

At the luncheon meeting held in the company's training building, the group was addressed by Adm. (Ret.) N. L. Rawlings, vice-president of the shipbuilding company, who stressed the necessity for quality castings in shipbuilding operations. L. A. Howell, foundry superintendent of the firm, also addressed the luncheon meeting.

The Southern group will operate as a section of the Chesapeake Chapter during the current fiscal year and meetings will be held bimonthly in several cities in Virginia and North Carolina. Chairman of the Chesapeake Chapter is J. O. Danko, Sr., Danko Pattern & Mfg. Co., Baltimore, Md. Among those who attended the meeting were J. C. Pendleton, former head of the Newport News Shipbuilding & Drydock Foundry, and AFS National Secretary Wm. W. Maloney.

Birmingham District

Approximately 200 members of the Birmingham District Chapter kicked off the 1955-56 season with the 22nd Annual Barbecue held at Cascade Plunge in Birmingham, Ala., September 17. Also in attendance were several members of the Chattanooga Chapter, including W. G. Greiser, Ross-Meehan Foundries, chapter chairman; W. M. Hamilton, Crane Co., a national

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director of the American Foundrymen's Society; G. F. Anderson, Tennessee Products, a director of the Chattanooga Chapter; and C. A. Johnson, Sommerville Iron Works, also a director of the Chattanooga Chapter.—*A. B. Schwarzkopf.*

Twin City

The September meeting of the Twin City Chapter was held at the Covered Wagon, Minneapolis. Guest speaker was Norman Qualey, plant engineer in charge of metallurgical inspection, Northern Pump Co., Minneapolis. In his speech, *"Inspection Tools in the Foundry,"* he pointed out that specifications are a guide from the engineer and should be established after carefully analyzing the end-use requirements of the casting. Appropriate inspection tools should be selected on the basis of the type of casting and the nature of the test to be run.

Twin City . . Fred Neal, membership chairman, is shown with the membership target presented to the chapter by O. Jay Myers.

O. Jay Myers, Archer-Daniels-Midland Co., and AFS national director and chapter advisor, presented the chapter with a huge target illustrating their membership goal for 1956. Fred Neal, Smith-Sharpe Co., membership chairman, explained the target to the members with the hope that the king-sized arrow could be placed in the bullseye by June 30, 1956.—*R. J. Mulligan.*

Texas

Almost 100 members and guests attended the opening session of the Texas Chapter which featured *"Fluid Flow of Light Metals Through Vertical Gating Systems,"* AFS sound-color film, at the Ben Milam Hotel in Houston.

Discussion of the principles set forth in the film was led by a panel consisting of: A. P. Guidi, Texas Electric Steel Castings Co.; H. M. Freeman, Texas Foundries, Inc.; Dan Roberts, Oil City Iron Wks.; and Pete Maenza, Dee Brass Foundry.

The film shows the action of liquid flow under simulated casting conditions in a way that cannot possibly be seen in actual practice plus verification the principles demonstrated by pouring actual castings.

Several questions from the floor inquired about the effects of materially differing density and viscosity of various metals cast, compared to plain water used in some of the laboratory demonstrations for the film. Mr. Guidi pointed out that the fundamentals demonstrated appeared sound regardless of such differences among metals, but that, of course, the application of these fundamentals would necessarily vary quite widely.

Discussion from the floor evolved around square vs. round shapes for sprues, runners and gates. It appeared that few of those present are now using rectangular shapes for this purpose Mr. Freeman reported successful experience with rectangular sprues and runners (experimental only) but round shapes continue to be used for regular production.—*J. S. Ahrens.*

Central Michigan

The first meeting of the Central Michigan Chapter was held at the Jackson Country Club. Gardner Lloyd, Albion Malleable Iron Co., chairman, introduced new members.

The speaker, Harry Gravlin, Claude B. Schreible Co., Detroit, was introduced by technical chairman Art Van Emst, Fuller Mfg. Co. Mr. Gravlin chose his subject, *"Why Not?"*, from a question he used to ask college students when he was doing employment interviews. When he asked the graduating seniors if they had considered the foundry as a place of employment, and they answered no, he asked them and himself "why not?"

The foundry, Mr. Gravlin stated,

Michiana . . Randy Storer waiting for the wind-up at the Michiana Chapter's annual picnic at Tabor Farms, Sodius, Michigan.

is not a place to be ashamed of. It is a good and progressive industry. To refer to your job as "down in the foundry" is to run down one of the most fundamental, necessary, forward-looking industries in the world, he pointed out.—*Jack Butters.*

Central Illinois

One hundred and twenty members and guests attended the September meeting initiating the 1955-1956 season. George Rockwell, Caterpillar Tractor Co., who served as technical chairman, introduced Don Gerlinger, Walter Gerlinger, Inc., Milwaukee, guest speaker, whose subject was *"Shell Cores."*

Mr. Gerlinger explained the development of the prototype equipment and cores made by the process. He cited economic advantages of the shell core processes, such as elimination of cost of driers, wires and dipping. He supplemented his talk by slides of equipment now being manufactured.—*H. L. Marlatt.*

Eastern New York

The first fall meeting of the Eastern New York Chapter was held at Panetta's Restaurant, Menands, N. Y. New officers were installed.

The speaker for the evening was Guy A. Pealer, General Electric Co., whose topic was *"Pattern Engineering."* His talk traces the history of metals from the dawn of civilization, outlining the advances that have been made possible through our utilization of metals. He brought the talk to our present day problems by stressing the necessity for co-ordination between designers and casting engineers.

Mr. Pealer feels that is is important to use well engineered patterns even though initial castings may be more expensive than if a cheaper pattern were used.He suggested pricing castings not only for a cheaper pattern but also pointing out the possibility of savings on longer runs by the use of a better pattern.—*Martin L. Slawsky.*

Michiana

About 300 members and guests attended the Michiana Chapter's annual picnic, September 17, at Tabor Farms, Sodius, Mich. Phil Semler, Auto Specialties Mfg. Co., was chairman of the picnic which included bait casting, horse shoe pitching, soft ball, golf, and a drawing for door prizes.

At the August meeting, held at the Club Normandy, Mishawaka, Ind., Dan Hayes of the AFS Central office spoke on membership possibilities. Final arrangements were made for the picnic, and an Educational Program was set up.—*Robert E. Hull.*

Mid-South

The September meeting of the Mid-South Chapter was held at the Rebel Motel with J. G. Winget, Reda Pump Co., Bartlesville, Okla., speaking on reverberatory furnaces. He said proper melting and alloying of gray iron is more easily done and controlled in a reverberatory furnace than with a cupola and is much less expensive than with an electric furnace—*M. B. Parker, Jr.*

Penn State Student Chapter

Officers elected for the 1955-56 season are: Kenneth Reisch, *chairman;* Larry Redmond, *vice-chairman;* Harry Nelson, *recording secretary;* Nick Kralles, *corresponding secretary;* and Frank Todd, *treasurer.* The program for the year has been set up and includes such topics as cupola operation, sand, brass melting, nodular iron, and interviewing.

STATEMENT OF OWNERSHIP

Statement required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946 (Title 39, United States Code, Section 233) showing the ownership, management, and circulation of MODERN CASTINGS AND AMERICAN FOUNDRYMAN, published monthly at Chicago, Ill., for October 1, 1955. 1—The names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, American Foundrymen's Society, Golf & Wolf Roads, Des Plaines, Ill.; Editor, Herbert F. Scobie, Golf & Wolf Roads, Des Plaines, Ill.; Managing Editor, none; Business Manager, Curtis G. Fuller, Golf & Wolf Roads, Des Plaines, Ill. 2—The owner is: American Foundrymen's Society, Golf & Wolf Roads, Des Plaines, Ill., organized not for profit, without stock. Principal officers: President, Bruce L. Simpson, National Engineering Co., Chicago; Vice-President, Frank W. Shipley, Caterpillar Tractor Co., Peoria, Ill.; Secretary-Treasurer and General Manager, William W. Maloney, American Foundrymen's Society, Golf & Wolf Roads, Des Plaines, Ill. 3—The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: none. 4—Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner. Curtis G. Fuller, Business Manager. Sworn to and subscribed before me this 19th day of September 1955 (Seal). E. R. May, notary public. (My commission expires March 14, 1956.)

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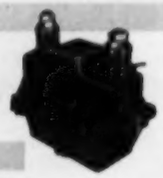

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CIRCLE NO. 106, PAGE 79-80

afs chapter meetings

NOVEMBER

1 . . Twin City . . Calhoun Beach Club, Minneapolis. AFS-ASM joint meeting. Speaker from Do-ALL Co. on *"Civilization Through Tools."*

1 . . Rochester . . Hotel Seneca, Rochester. G. M. Etherington, American Brake Shoe Co., *"Shell Molding."*

3 . . Canton District . . Elks Club, Barberton, Ohio, Prof. Richard A. Flinn, Dept. of Chemistry and Metallurgy, University of Michigan, *"Ductile Iron."*

3. . . Saginaw Valley . . Fischer's Hotel, Frankenmuth, Mich. Individual Group Meeting. Iron & Steel— *"New Alloy Developments,"* H. P. Rassbach, Electro-Metallurgical Co. Light Metals —*"Early Experiences in the Development of Magnesium,"* Arthur W. Winston, Dow Chemical Co.

3 . . Western New York . . Past Chairmen's Night. Frank E. Bates, Semet Solvay Corp., Buffalo, N. Y.

3-4 . . Metals Casting Conference, Purdue University, West Lafayette, Ind. *Sponsored by the Central Indiana and Michiana Chapters of the American Foundrymen's Society.*

4 . . Birmingham District . . Anniston Country Club, Anniston, Ala. Panel discussion on Soil Pipe.

7 . . Chicago . . Chicago Bar Association, Chicago. Robert E. Kennedy Night. Round Table Meeting. Steel & Malleable Div.—*"Foundry Sands,"* Bradley Booth, Carpenter Bros., Milwaukee. Gray Iron Div.—*"Manufacture and Application of Foundry Coke,"* Clarence Holmes, Citizens Gas and Coke Utility, Indianapolis. Maintenance Div.—*"Are You Working in the Dark,"* Carl W. Zersen, Chicago Lighting Institute. Non-Ferrous and Pattern Div.—*"Permanent Molding."*

7 . . Central Illinois . . Legion Hall, Peoria, Hans J. Heine, American Foundrymen's Society *"Challenge of Modern Foundry Technology"* and AFS Vertical Gating movie.

7 . . Metropolitan . . Essex House Hotel, Newark. John M. South, Foundry Services Inc., *"The CO_2 Core Process."*

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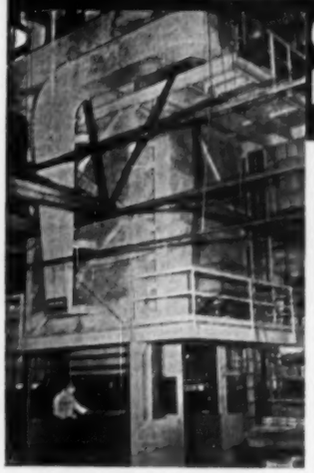

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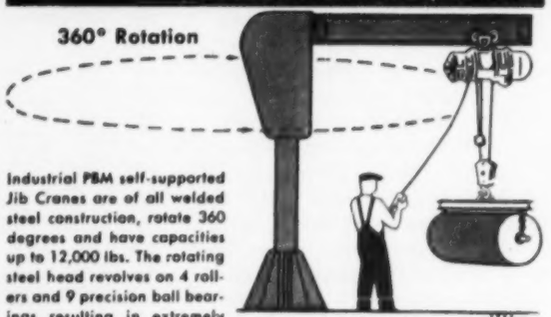

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7 . . Western Michigan . . Grand Rapids. Roy Carver, Carver Foundry Products Co., *"CO_2 Core Process."*

10 . . Northeastern Ohio . . Tudor Arms Hotel, Cleveland. C. E. Wenninger, National Engineering Co., Chicago, *"Sand Fundamentals."*

10 . . St. Louis District . . York Hotel, St. Louis. Roy Carver, Carver Foundry Products Co., *"CO_2 Process."*

11 . . Southern California . . Rodger Young Auditorium, Los Angeles, O. C. Bueg, Arrow Pattern & Engineering Co., Erie, Pa., *"Metal Patterns for High Production."*

11 . . Philadelphia . . Engineers' Club. Chester A. Thomas, National Engineering Co., *"Progress in Foundry Automation."*

14 . . Northern California . . Spenger's Fish Grotto, Berkeley. O. C. Bueg, Arrow Pattern & Engineering Co., Erie, Pa., *"Metal Patterns for High Production."*

14 . . Michiana . . Club Normandy, Mishawaka, Ind. Ferrous—*"Use and Mis-use of Green Sand Molding Mixtures,"* C. A. Sanders, American Colloid Co., Chicago. Non-Ferrous—"Metallurgy in the Brass Foundry," William Ball, Jr., R. Lavin & Sons, Chicago.

16 . . Oregon . . Heathman Hotel, Portland. O. C. Bueg, Arrow Pattern & Engineering Co., Erie, Pa., *"Metal Patterns for High Production."*

16 . . Central Michigan . . Hart Hotel, Battle Creek. Youth Encouragement Night. Talk by Ashley Sinnett, AFS National Headquarters. Film of Notre Dame vs Navy football game.

17 . . Washington . . Poodle Dog Cafe, Tacoma. O. C. Bueg, Arrow Pattern & Engineering Co., *"Conventional Patterns."*

17 . . Detroit . . Tuller Hotel, Detroit. C. A. Sanders, American Colloid Co., Chicago. *"Foundry Sand."*

18 . . British Columbia . . P. A. Club, Vancouver. O. C. Bueg, Arrow Pattern & Engineering Co., Erie, Pa., *"Conventional Patterns."*

18 . . Tennessee . . Hotel Patten, Chattanooga. H. W. Schwengel, Modern Equipment Co., *"The Closed Top Cupola."*

18-19 . . New York State-Canada-Pennsylvania Regional Foundry Conference, Onondaga Hotel, Syracuse, N. Y. *Sponsored by the Central New York, Eastern Canada, Eastern New York, Northwestern Pennsylvania, Ontario, Rochester, and Western New York Chapters of the American Foundrymen's Society.*

21 . . Quad City . . Fort Armstrong Hotel, Rock Island, Ill. Walter George George & Dix Co., *"Foundry Costs for the Supervisors."*

25 . . Chesapeake . . Engineers Club, Baltimore, Md. Movie Night.

29 . . Twin City . . Covered Wagon, Minneapolis. M. J. Allen, American Steel Foundry, Chicago.

DECEMBER

1 . . Canton District . . American Legion, Massillion, Ohio. C. A. Sanders, American Colloid Co., Chicago, "Synthetic Sand vs Natural Bonded Sand."

1-2 . . Michigan Regional Foundry Conference, Michigan State University, East Lansing. *Sponsored by the Central Michigan, Detroit, Saginaw, and Western Michigan Chapters of the American Foundrymen's Society and their Michigan State University and University of Michigan Student Chapters.*

2 . . Western New York . . Roy Carver, Carver Foundry Products Co., Muscatine, Iowa, *"CO_2 Process."*

3 . . Central Michigan . . Hart Hotel, Battle Creek. Annual Christmas Dinner Dance.

5 . . Central Indiana . . Athenaeum Turners, Indianapolis. *"Melting Practice in Our Foundry,"* Dallas Lansford, Perfect Circle Corp.; Fred Carl, General Motors Corp.; Larry Emery, Marion Malleable Iron Works.

5 . . Chicago . . Chicago Bar Association. Round Table Meeting. Gray Iron Div.—*"Characteristics and Applications of Ductile Iron,"* David Matter, Manufacturing Research, International Harvester Co. Malleable & Steel Div.—*"Where to Look for New Business,"* Eric Welander, John Deere Malleable Works, East Moline, Ill. Pattern Div.—*"Advantages of a Wood Milling Machine in your Pattern Shop,"* Robert Wright, Oliver Machinery Co., Grand Rapids, Mich. Maintenance & Non-Ferrous Div.—*"Foundry Heating and Ventilating,"* T. A. Lyon, DuBois Engineering Co., Hammond Ind.

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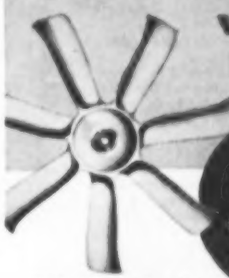
CIRCLE NO. 109, PAGE 79-80

performance is in the "prop"



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Davenport 40A, 40SA, 28SA, 34AJS
Herman 40" x 60" 6000 lbs.
Osborn 405-95, 26" draw
Jolt Squeeze Strip—Nichols 24-54D
Jolt Pin Lift—Davenport . . . Nichols
Milwaukee . . . Herman

MOLD CONVEYORS

1-Link-Belt Roller type, 27' x 70' 6" centers. 35 cars 38" x 72". 1-Webb Co. heavy duty, 109 cars 32" x 39".

WE BUY and SELL COMPLETE FOUNDRIES
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WE CARRY ALL MAKES AND TYPES OF FOUNDRY EQUIPMENT IN STOCK
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For Sale,
Help Wanted,
Personals,
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set solid . . 2Ûc per word, 30 words ($6.00) minimum, prepaid.

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HELP WANTED

DESIGNERS-DRAFTSMEN-ENGINEERS, experienced in foundry layouts and equipment. Age 30-45. Send experience record, personal data, recent photo and references. **Box C76 MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

FOUNDRYMAN

LARGE EASTERN MALLEABLE FOUNDRY HAS OPENING FOR PRODUCTION FOREMAN THOROUGHLY FAMILIAR WITH GATING, RISERING AND MOLDING OF MALLEABLE IRON. SEND RESUME INCLUDING EXPERIENCE AND SALARY DESIRED. ALL REPLIES HELD CONFIDENTIAL. **Box C77 MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

TECHNICAL SALES ENGINEERS-Aggressive and rapidly expanding company with worldwide connections supplying technical service and products direct to foundries seeks first-class sales engineers, age 30-40. Metallurgical or foundry trade experience required but outstanding sales ability first consideration. Salary and expenses. Attractive offer for right man. **Box C78 MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

ASSISTANT FOUNDRY FOREMAN. If you can supervise men and know foundry procedures we have the job for you. Send resume and salary requirements. Chicago area. **Box C80 MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

FOUNDRY SALES ENGINEER. Experienced in various phases of foundry practice to cover Indiana and Western Michigan for long established foundry supply company. Liberal drawing account and commission. Give complete details as to personal history, foundry and sales experience. All information held in strictest confidence. **Box C81 MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

MOLDING FOREMAN or Assistant. Mechanized Midwest Foundry wants aggressive foreman for molding department. Give personal history, references, and salary. **Box C69, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

FOUNDRY ASSISTANT needed by captive gray iron foundry of medium size heavy process machinery manufacturer. Young college engineer graduate preferred. Should have had some foundry experience. Is to help increase plant efficiency, planning, research and operation. Company has liberal profit sharing plan. Salary open. Location S. E. Penna. Reply **Box C65, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

LIGHT METALS FOUNDRYMAN

Large modern non-ferrous foundry in Southern California is seeking a man with experience and a thorough practical knowledge of gating, risering and foundry techniques in aluminum and magnesium sand castings. Must be able to hold close tolerances and produce X-ray quality. This is a top job with top pay for the man who can demonstrate ability to produce high quality precision sand castings.
Please send detailed resume of personal and work histories; also a recent photo if possible. Job is now available. Personal interviews will be arranged for qualified applicants and all replies will be held confidential. Address reply to **Box C79, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

METALLURGIST OR FOUNDRY ENGINEER. Progress medium-sized investment casting concern located in the suburban East is planning to augment its research and development activities by adding a Project Head to organize and lead a group on foundry research as applied to processing and products. Must have had the experience to be qualified to plan and execute development work in sand, shell and investment casting as applied to all phases of the precision casting field. Sincerely believe growth possibilities are good both in scope of work and within the organization. This company is ready to meet the salary requirements of the right man for this position. Please submit full details of background and experience to **Box C82 MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

REPRESENTATIVES

Representatives wanted by production forging shop Non-ferrous metals. **Box C83, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

We want several live-wire salesmen who are now working on salary and who think that they could increase their earnings by selling on liberal commission. These men must have followings in industries buying master alloys and hardeners. Please give full details in your first letter, i.e., personal history, employment record, territory, etc. Your information will be held in strictest confidence. **Box C70, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

ENGINEERS. Immediate openings for high caliber men with degrees in mechanical engineering, industrial or managemnt engineering, metallurgy, civil engineering and physics, at salaries ranging from $4345.00 to $8990.00, to perform vital work in connection with the design and development of ordnance materiel. **Mr. R. F. Donohue (Albany or Troy-Extension 2201) Civilian Personnel Officer, Watervliet Arsenal, Watervliet, New York.**

INSPECTOR Large gray iron foundry in Midwest needs castings inspector experienced on large gray iron castings. This man must be capable of reading blueprints so castings can be inspected for dimensional accuracy. He should know enough about welding of gray iron to direct the welding of castings, as well as determining stress relieving necessity for castings after welding. He should be thoroughly experienced in all cleaning room operations. State experience, education, and salary required. **HANSELL-ELCOCK COMPANY 485 West 23rd Place, Chicago 16, Ill.**

POSITIONS WANTED

PLANT ENGINEER, BSME, U of Michigan 1952, 2 years experience Foundry Construction Installation and Maintenance Equipment. Resume on request. **Box C74, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

FOUNDY SUPERINTENDENT OR MANAGER. 22 years practical experience, ferrous and nonferrous, jobbing and production. Qualified to take control all foundry operations. 15 years as foreman, superintendent, and manager. Complete resume education and experience upon request. **Box C75 MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

FOUNDRY ENGINEER M.E., age 27, married, with diversified post-graduate training and experience in foundry and related manufacturing. Capable writer. Desire jobbing production foundry experience. **Box C84 MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

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Utilize the latest in conventional and shell CORE BLOWING METHODS to offset present high costs and competition by use of: Existing Equipment when Possible—Improved Equipment Design—Improved Methods and Standards—Training of Supervision and Personnel. For CONSULTING SERVICES CONTACT **Box C71, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

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217 CENTRE STREET
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Small lofts-total area
2,000 SQ. FT.
Suitable as offices & display rooms
Ideal for Metal & Tool concerns
seeking to locate in New York City
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ZYGLO MACHINE

One Type—ZA—2D—Ser. No. M2—4340—220 V. 3 Ph. 60 Cyc. Equipped with penetrant tank, rinsing station hot water dip tank. Black light inspection at washing; drying chamber; developing station and black light inspection station. Baskets, penetrant and developing powder included. **LUNKEMHEIMER CO. P.O. Box 360 Annex Station, Cincinnati 14, Ohio. Purchasing Department.**

FURNACES FOR SALE

10 used Heat Treating Furnaces, and two 7-ton gantry cranes, good condition, priced to sell.

BAER STEEL PRODUCTS, INC.
Box 1428
Boise, Idaho

TREMENDOUS VALUE—
ALMOST NEW CORE OVEN—
PRICED AT LESS THAN HALF REPLACEMENT COST

"Despatch Tower" (75 ft. high) Core oven, Serial #21548, *Complete*, Dismantled, with the following specifications:

Maximum temperature—500° F.
Average baking time—4 hours
Output—Approximately 5 racks per hour
Rack dimensions—36" x 102" x 26" high, over all
Total number of racks—27 (20 racks in the oven at one time)
Rack capacity—400 lbs.
Heater—"Despatch" direct gas, 1,500,000 BTU per hour (Heater is externally mounted)
Combustion equipment—"Eclipse" atmospheric type
Electric current specs:
Motors—440/220 v. 3 phase 60 cycle
Controls—110 v. 1 phase 60 cycle A.C.
Fuel—Natural gas, 6" - 8" W.C.

THIS OVEN IS LIKE NEW—
IN USE ONLY THREE YEARS.

A complete set of drawings, including one assembly drawing and twenty-eight related drawings, is available upon request.

PRICE—A BARGAIN AT $20,000.00

For further information, please contact Mr. Don Kelker, Purchasing Agent or Mr. Don Smith, Plant Engineer.

THE DURIRON COMPANY, INC.
Dayton, Ohio

It's easy to obtain product data with the postage-free Reader Service Cards provided on pages 79-80. Use them for information on advertised products, too. Just circle the key number appearing at bottom of the ad.

Use Radioactive Tracers

A research program to investigate the application of radioactive tracers to the study of metallurgical problems is described in a report just made available to industry by the Office of Technical Services, U. S. Department of Commerce. The research was conducted for Army Ordnance by the Engineering Research Institute, University of Michigan.

The great value of high-resolution autoradiography as a metallurgical research tool is demonstrated by the results of this research. Among the problems studied using autoradiography were diffusion of nickel into iron, distribution of sulphides in iron, distribution of bismuth in copper, diffusion of liquid bismuth into copper, diffusion of nickel into copper, distribution of hydrogen in copper-tin alloys, and distribution of sulphur in spherulitic cast iron.

To obtain a copy of the final report describing techniques and experimental methods, order PB 111558 from OTS, U. S. Department of Commerce, Washington 25, D. C., price, $2.25.

Film Brass Candlestick Story

"The Spiked Candlestick," a 13½-min., 16mm color film is now available free of charge. The film is largely the history of a Williamsburg reproduction as it goes from the pattern shop through the core room, foundry, and machine shop to final packing and shipping.

The film was made and is being distributed by the Virginia Metalcrafters, Inc., makers of Williamsburg restoration brass and iron reproductions, Waynesboro, Va.

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"THAT GOOD"
FOUNDRY COKE
DEBARDELEBEN COAL CORPORATION
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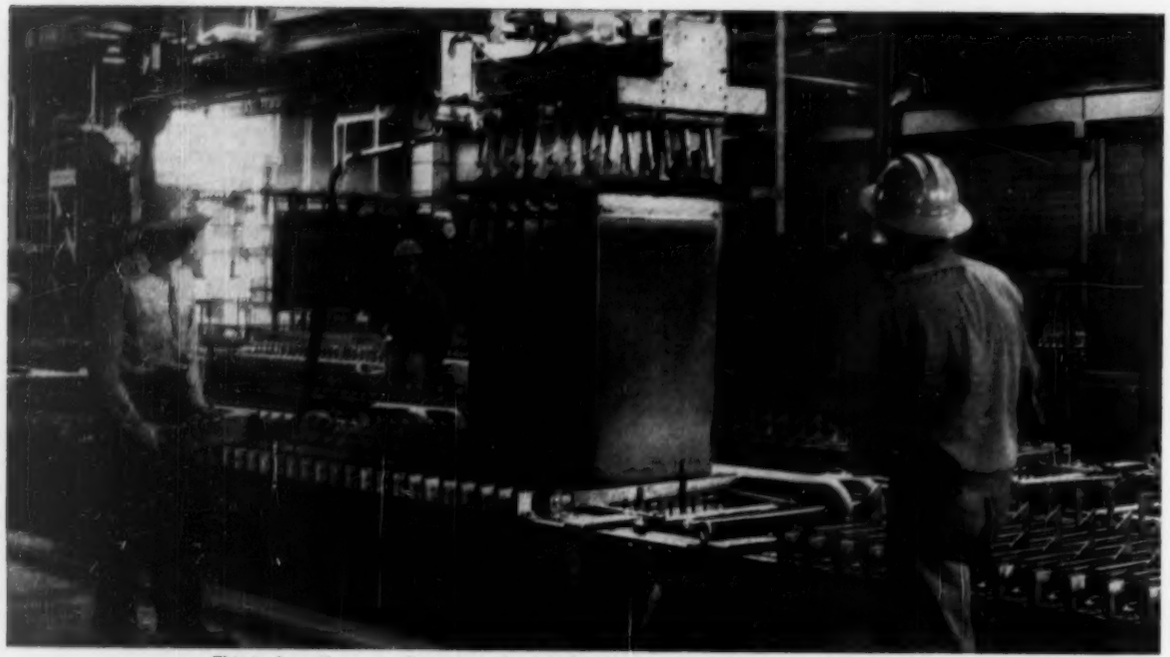
Phone 3-9135

CIRCLE NO. 115, PAGE 79-80



This is the cell room in ELECTROMET's new electrolytic manganese plant at Marietta, Ohio.

Now Available! "ELECTROMET"

Trade-Mark

ELECTROLYTIC MANGANESE 99.9% pure

For all uses where a high-purity manganese is required...

ELECTROMET's process for making electrolytic manganese produces high-purity metal with a minimum of 99.9 per cent manganese. This material is well suited for all uses where high-purity manganese is required, as in the production of low-carbon stainless steels, high-temperature alloys, non-ferrous alloys, and electrical resistance alloys.

Nitrogen-Bearing Electrolytic Manganese — A nitrided electrolytic manganese, containing about 6 per cent nitrogen and 93 per cent manganese, is also available for metallurgical uses from ELECTROMET.

Specifications of ELECTROMET Electrolytic Manganese

Analysis: Manganese 99.9% min. (on metallic basis)

Nitrogen-bearing Grade — approx. 93% manganese
approx. 6% nitrogen

Dehydrogenated material is available.

Packaging: Usually packed in steel drums holding 500 lb. of material. Smaller packages available at small premium.

For further information about ELECTROMET electrolytic manganese metal, and other ELECTROMET ferroalloys and metals, please contact the nearest ELECTROMET office listed below.

ELECTRO METALLURGICAL COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street UCC **New York 17, N. Y.**

OFFICES: Birmingham • Chicago • Cleveland • Detroit
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In Canada: Electro Metallurgical Company, Division of Union Carbide Canada Limited, Welland, Ontario

The term "Electromet" is a registered trade-mark of Union Carbide and Carbon Corporation.

CIRCLE NO. 97, PAGE 79-80

for the asking

continued from page 84

indicated in photographs. *E. I. Du Pont De Nemours & Co., Inc.*

CIRCLE NO. 77, PAGE 79-80

Marking with Adhesives

Bulletin 165 describes fast, economical marking of factory areas, columns, boxes, stations, shelves, machines, parts and assemblies, equipment, cabinets and files with self-sticking, all-purpose numbers and letters. All-temperature material is good from —300 to +300F and even intervals to 450F. One material outlasts painted marking 5 to 1. *W. H. Brady Co.*

CIRCLE NO. 78, PAGE 79-80

Pyrometry Hints

New Bulletin F 7259 gives service tips for pyrometer users. Included are "What to do if instrument is reading erratic," "Instrument temperature curve off," "Instrument reading too high," "too low", and "Instrument controls erratically." *Wheelco Instruments Div., Barber-Colman Co.*

CIRCLE NO. 79, PAGE 79-80

Specimen Cut-Off

Featured in the AB Metal Digest, Vol. 1, No. 3 is the 1005 AF Subject Attachment to make the No. 1000 AB Abrasive Cut-Off Machine more effective in preparing critical micro sections. Combination of jet cooling and specimen immersion make it possible to cut hardened material with no evidence of burning or change of structure. *Buehler Ltd.*

CIRCLE NO. 80, PAGE 79-80

Die Casting Finishing

Technical Bulletin PP-125, "Successful Stevens L. V. Finishing of Aluminum and Zinc Base Die Castings" recommends type and size of buff or wheel, minimum number of operations required, wheel speed, and abrasives or compositions. *Frederic B. Stevens, Inc.*

CIRCLE NO. 130, PAGE 79-80

Spectrograph

New model 3-meter Concave Grating Spectrograph provides wavelength coverage in a single exposure which is double that of previous models. This new instrument is said to photograph

more of the spectrum in one exposure, at high dispersion, than any other concave spectrograph commercially available. Complete operating details and specifications are given in Bulletin 52. *Baird Associates, Inc.*

CIRCLE NO. 131, PAGE 79-80

Air Control Valves

The Ross line of air operated control valves described in Bulletin 101B features the poppet type for positive seal; is said to be self aligning, quick opening, and pass foreign material. Materials are corrosion resistant, valve is easy to operate, sturdily constructed, has oil resistant O-rings and seats. *Ross Operating Valve Co.*

CIRCLE NO. 132, PAGE 79-80

Let's Shake

New, 48-page condensed Catalog 5510 describes many pieces of foundry equipment incorporating the vibrating principle: feeders, conveyors, vibrators, etc. Includes also other equipment of the line of *Syntron Co.*

CIRCLE NO. 133, PAGE 79-80

Molding Machine

Special features of line of type BT jolt, squeeze, turnover, and pattern draw molding machine include jolt timer, press button operation, streamlined for easy cleaning, automatic lubrication, automatic pneumatic anvil, built-in air filters, easy mold removal, simple operation. 34-page booklet AB/658 includes specifications and instructions. *British Molding Machine Co., Ltd.*

CIRCLE NO. 134, PAGE 79-80

Melting Equipment

Bibliography of 119 articles in recent literature dealing with melting equipment. Most articles are from North American publications, some from British, a few are from foreign language magazines. *American Foundrymen's Society.*

CIRCLE NO. 135, PAGE 79-80

Belt Maintenance Tips

Wall chart (23 x 33-in.) gives 12 practical maintenance tips for getting more life out of belts. It deals with storage, loading chutes, automatic switches, lubrication, inspection, and lists types of belt for various uses. *Hewitt-Robins Inc.*

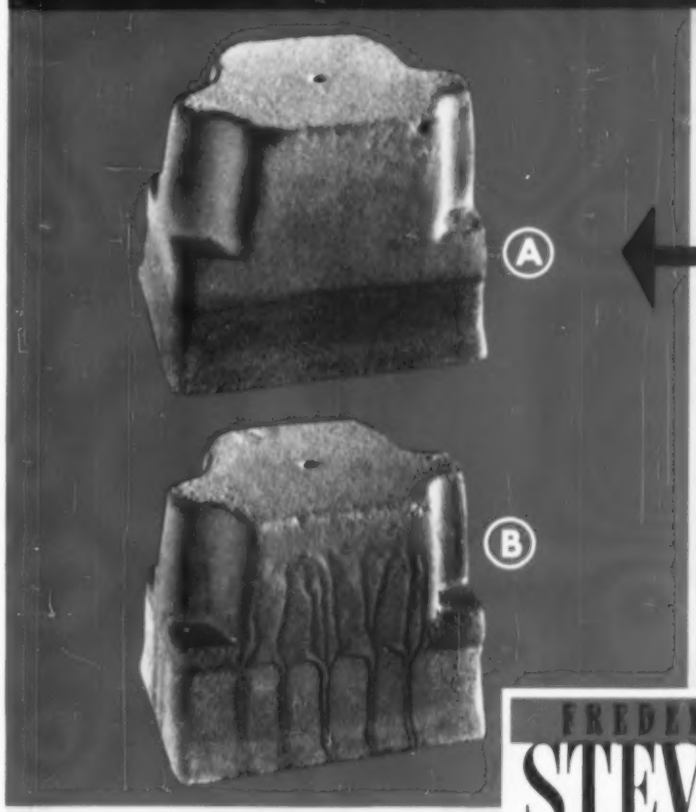
CIRCLE NO. 136, PAGE 79-80

CIRCLE NO. 98, PAGE 79-80

THEY'RE NEW! THEY'RE DIFFERENT!

2 NEW STEVENS CORE COATINGS

FOR BETTER CASTINGS—AT LOWER COST



STEVENS GRAPH-KOTE

A GRAPHITE CORE COATING

The unretouched illustrations at the left show (A) a core that has been dipped in the new Stevens Graph-Kote Core Coating while (B) shows another core dipped in an ordinary core coating. Observe the difference between these two coatings. Stevens Graph-Kote shows no bleed, no run-down, no tear-drops, no build-up, while the other coating shows all of these defects. The new Stevens Graph-Kote produces better castings at lower cost when used on cores and molds for grey iron, non-ferrous and alloy castings. It produces a true grey iron color on castings.

STEVENS RED-SKIN

A REFRACTORY CORE COATING

Below are shown unretouched photographs of (C) a core dipped in the new Stevens Red-Skin Core Coating and (D) a similar core dipped in a standard type carbon-free core coating. Note the difference between these coatings. Stevens Red-Skin does not run, streak, tear-drop or pile up at the edge of the core. The other coating shows inferior application. The new Stevens Red-Skin reduces costs and aids in the production of better castings when used on molds and cores for steel, grey iron and non-ferrous. It is carbon-free and is highly refractory.

FREDERIC B. STEVENS INCORPORATED
EVERYTHING FOR A FOUNDRY
DETROIT 31, MICHIGAN

After months of research, formulation and testing in foundries under varied conditions, the Stevens Laboratories are proud to introduce two new and different core coatings — Stevens Graph-Kote and Stevens Red-Skin. Both have advantages to foundrymen.

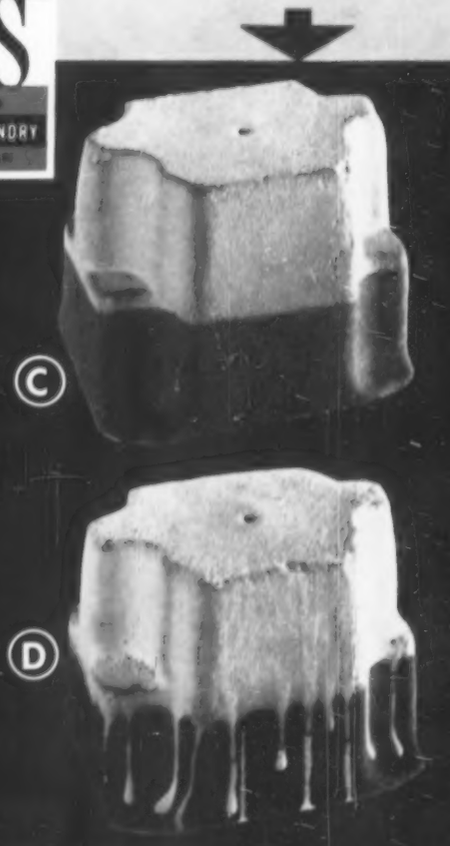
Will Reduce Labor Cost: Since both Graph-Kote and Red-Skin are "short" they coat only where a coating is needed. The dip line is sharp. No run-downs, sags, tear-drops or build-up to clean from cores. Cores can be dipped faster, core prints and assemblies fit accurately and conveyors and oven racks are kept cleaner.

Both Have Deep Penetration: For protection against metal penetration Graph-Kote and Red-Skin seal several layers of sand to insure easy peel from castings. An even, uniform coating gives ample coverage to produce clean castings.

Are Tough and Rugged: Will withstand the most severe conditions of impinging and flowing metal since the coatings are firmly anchored to mold and core surfaces and are resistant to high pouring temperatures.

Other Advantages: Stevens Graph-Kote and Red-Skin form smooth, foam-free solutions. They are ready to use, with no waiting period, as soon as they are completely mixed. Can be stored indefinitely without deteriorating in polyethylene lined containers.

To get better castings at lower cost investigate Stevens Graph-Kote and Red-Skin Core Coatings today.



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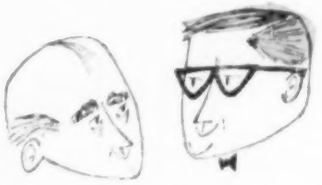
IN ELECTRIC FURNACES

"The Whiting Hydro-Arc Furnace has real cost-saving advantages."

"Uni-directional electrode motors . . . no reversing."

"Arc regulation to a fixed standard."

"Electrode motors driven directly from arc-furnace bus without extra machinery."



"Regulated watt-input or heat-input to furnace. More efficient utilization of power input."

"Installation costs are lower—all these factors lead to better control and lowest cost per ton of melt."

"Only a few years ago, such electrode speed, acceleration and response were considered impossible."

"The least number of moving parts."

"Electrode consumption and refractory costs are lower."

"Let's send for the Whiting Arc Furnace Bulletin FY-168 . . . it gives all the facts!"

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HYDRO-ARC

WHITING CORPORATION
15628 Lathrop Avenue, Harvey, Illinois

modern castings *and* **American Foundryman**

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